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THE
NEW SYSTEM OF GYNAECOLOGY



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THE NEW SYSTEM OF GYNAECOLOGY

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IN THREE VOLUMES

WITH NUMEROUS ILLUSTRATIONS IN COLOUR
AND IN BLACK AND WHITE

VOLUME I

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PREFACE

THE plan of this work was laid down and many of the Articles were actually written when the European War broke out in August 1914. The difficulty of completing our task amid the many preoccupations of these times has been very great, alike for the Editors, the Contributing Authors, and the Publishers, although we have never wavered in our determination to carry out our project.

The work was originally contemplated because in the opinion of the Editors the time had arrived when it was necessary to put into concrete form the great changes through which Gynaecological Practice in this country has passed during the last ten years. The change may be briefly summarized by saying that Gynaecology has become definitely a special branch of surgery, in close touch with abdominal surgery generally, and the old view that the gynaecologist is a physician not a surgeon is no longer tenable. In consequence of this development the interests of the gynaecologist have necessarily broadened. Pelvic disease in women is frequently associated, in the relation of cause or of effect, with diseases of the gastro-intestinal and urinary canals; the gynaecologist has accordingly realized that he must be prepared to deal with whatever condition he may find on opening the abdomen for the relief of disease apparently of pelvic origin. And further, he must be familiar with the special methods which are employed in the investigation of such diseases as those of the kidney, the bladder, and the rectum. Diseases of the female breast fall so obviously into the province of the gynaecologist that no explanation of the inclusion of this subject is called for. The vermiform appendix possesses relationships of *unique* intimacy with the pelvic organs, and there is no doubt that cases of appendicitis in women very frequently come under the care of the gynaecologist. During pelvic operations, injury to the intestines necessitating enterorrhaphy or enterectomy frequently occur, with which it is quite obvious that he must be prepared to deal. And further, during convalescence from abdominal operations, intestinal complications may arise which call for a sound knowledge of intestinal surgery.

In order to embody these developments it was necessary to extend the scope of the

System far beyond the conventional boundaries of Gynaecology. The result is seen to be a work which we may fairly claim to be the most comprehensive Gynaecological Treatise which has appeared in any language.

Certain Obstetric subjects, *e.g.* the Infections, and Operations on the Gravid Uterus, have been included, and in our opinion this is necessitated by the fact that such conditions so frequently come under the care of a gynaecologist. A practical knowledge of Obstetrics forms an essential part of the training of a gynaecologist on account of the numerous points at which they overlap, and there is no doubt that Gynaecology has suffered in the past from the incursions of those who are not qualified by training to understand its clinical problems aright.

The Editors have been so fortunate as to secure the co-operation of the ablest British Gynaecologists, a large proportion of whom are young men; and in addition two representative American Gynaecologists have done them the honour of collaborating with them. In the case of subjects which are not solely within the limits of Gynaecology, the assistance of distinguished men with special knowledge and experience has been secured.

The work of such well-known writers as the Contributing Authors of this System needs no word of commendation from the Editors; indeed these Articles will be found to be not only an embodiment of current knowledge and conclusions, but to present in several instances definite advances in knowledge, and to promote simplicity in teaching. Each Author is solely responsible for the views and opinions expressed in the respective Article.

It will be observed that many of the Contributing Authors are engaged in active military service either at home or abroad; but in every necessary case the Author has finally revised the Article immediately before proceeding to press, so it is hoped that no advance, however recent, has been excluded. The Editors deeply regret the untimely loss of the late Mr. Scott Carmichael of Edinburgh, whose article they have revised for publication themselves.

To the Publishers our grateful thanks are due for the most liberal manner in which all the great experience and resources of this famous House have been placed at our disposal. The large number of coloured plates form a unique feature in British medical publications, and the excellence of their production will, we are confident, receive general recognition. To the artists who have worked for us, often under conditions of great difficulty, our grateful thanks are also due, and special mention should be made of Dr. Dupuy, and Messrs. Maxwell, Shiells, Sewell, and Ford.

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ANATOMY OF THE FEMALE PELVIC ORGANS

By Professor G. ELLIOT SMITH and J. S. B. STOPFORD, M.D.
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THE description of the anatomy of the female pelvic organs will be arranged under the following subdivisions :

I. The development of the organs.

II. The anatomy of the adult female bony pelvis and the muscles forming the pelvic diaphragm.

III. The anatomy of the external female genital organs and the superficial perineal muscles.

IV. The anatomy of the contents of the female pelvis, including a description of the pelvic peritoneum.

V. The anatomy of the connective tissue, blood-vessels, nerves, and lymphatics of the female pelvis.

VI. The supports of the uterus.

The minute structure of the pelvic organs will be described in the Article on Physiology (p. 39).

I. THE DEVELOPMENT OF THE ORGANS ¹

A brief *résumé* of the development of the female genital organs is necessary in order that certain congenital malformations may be rendered intelligible, although the subject is too complex to permit full consideration in this chapter.

In the 5-mm. embryo a number of transverse columns of cells are found in that area of the mesoderm known as the intermediate cell-mass. Of these columns the most cephalic remain solid and quite vestigial, and probably represent the pronephros. The intermediate columns form the tubules of the mesonephros (Wolffian body), and open laterally into the Wolffian duct which passes caudally to the cloaca. The most caudal columns later form the metanephros (permanent kidney) and eventually

¹ Keibel and Mall, *Manual of Human Embryology*, 1910.

join the rudiments of the ureter, pelvis, and collecting tubules of the kidney, which are developed from a diverticulum arising from the lower end of the Wolffian duct.

The ovary is developed in the lumbar region from that part of the intermediate cell-mass which lies medial to the nephrogenetic tissue, where the organ is first represented by the genital ridge (Fig. 1). This ridge is covered by the "germ epithelium," which consists of the parent-cells of the ova and their follicles grouped to form part of the lining of the coelom. Very soon the germ epithelium produces ingrowing columns of cells which the mesodermic stroma breaks up into isolated

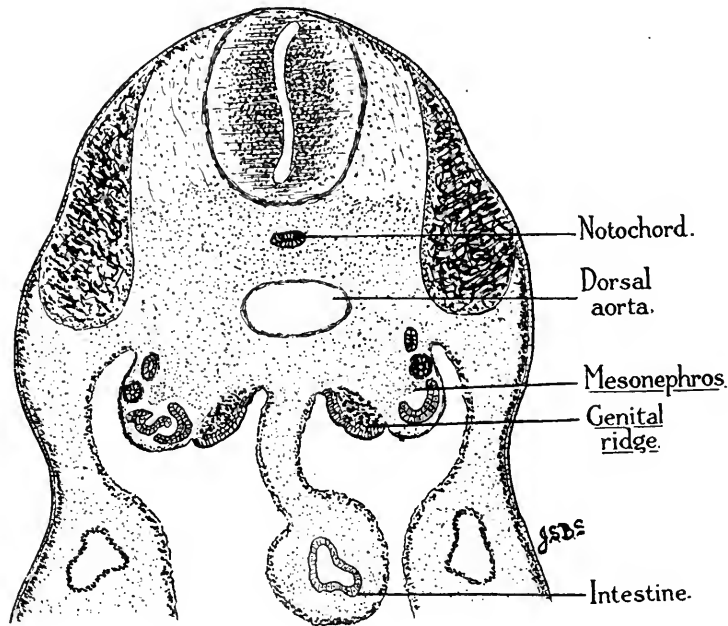


FIG. 1.—Transverse section of a 5-mm. human embryo in the region of the mesonephros and genital gland. The relative positions of the mesonephros and genital ridge, which are formed from the intermediate cell-mass, are shown at an early stage.

masses to form the Graafian follicles. As already stated, the ovary is developed in the lumbar region, but later it is moved down into the pelvis. There is some uncertainty as to the part played in this apparent movement by the muscular fibres contained in the *plica gubernatrix*, a fold which extends primarily from the lower pole of the ovary to the lower part of the anterior abdominal wall. Inferiorly the muscle fibres are attached secondarily to the labium majus, after they have penetrated obliquely the abdominal wall and so formed the inguinal canal.

Lying to the lateral side of the cephalic part of the Wolffian duct will be found the Müllerian duct, which crosses the former caudally to fuse with the Müllerian duct of the opposite side. The fused portion of the Müllerian ducts opens into the

cloaca in close proximity to the entrance of the Wolffian ducts. Higher up in the abdomen the four ducts, passing caudally together, form a ridge across the coelomic cavity described as the genital cord. The ununited parts of the Müllerian ducts

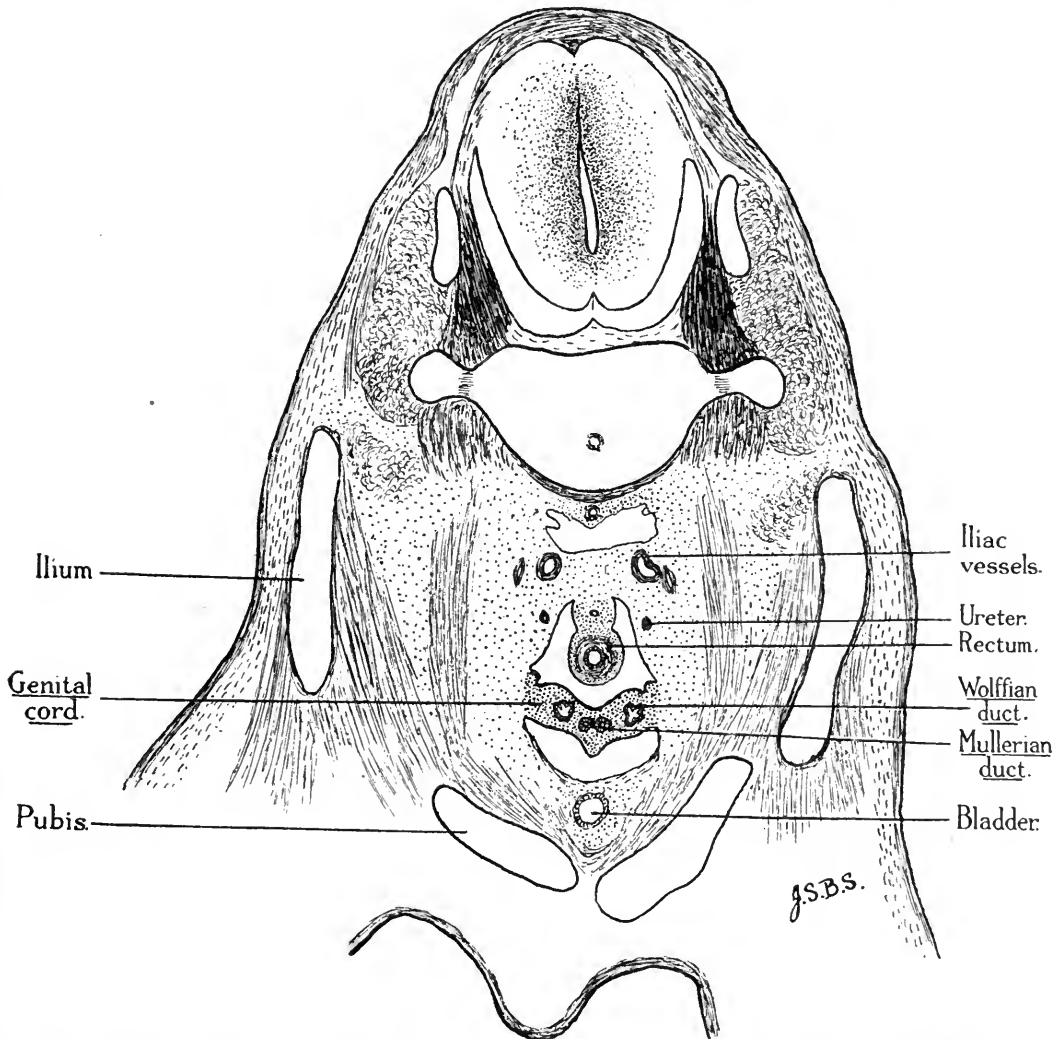


FIG. 2.—Transverse section of a 27-mm. human embryo. To show the relative positions of the Wolffian and Müllerian ducts in the genital cord. The genital cord extends across the coelomic cavity.

persist as the Fallopian¹ tubes whereas the fused portion of the ducts forms the uterus and, by means of a downgrowth, the vagina.²

The fusion of the Müllerian ducts occurs at the point where they are crossed by

¹ In deference to the ordinary usage we have retained the erroneous spelling, but the anatomist's name was Falloppius.

² Berry Hart, *Journ. Anat. and Phys.*, 1900, vol. xxxv. p. 330 ; F. Wood Jones, *Brit. Med. Journ.*, December 17, 1904 ; and E. J. Evatt, *Journ. Anat. and Phys.*, 1911, vol. xlv. p. 122.

the plica gubernatrix, and thus the latter structure becomes divided into two parts (Fig. 4): a cephalic part stretching between the ovary and the uterus (ligament of the ovary), and a caudal part extending from the uterus to the labium majus (round ligament of the uterus). Like the Wolffian ducts, the Müllerian ducts are at first solid but soon become tubular.

The ovary and the Wolffian and Müllerian ducts, together with the meso-

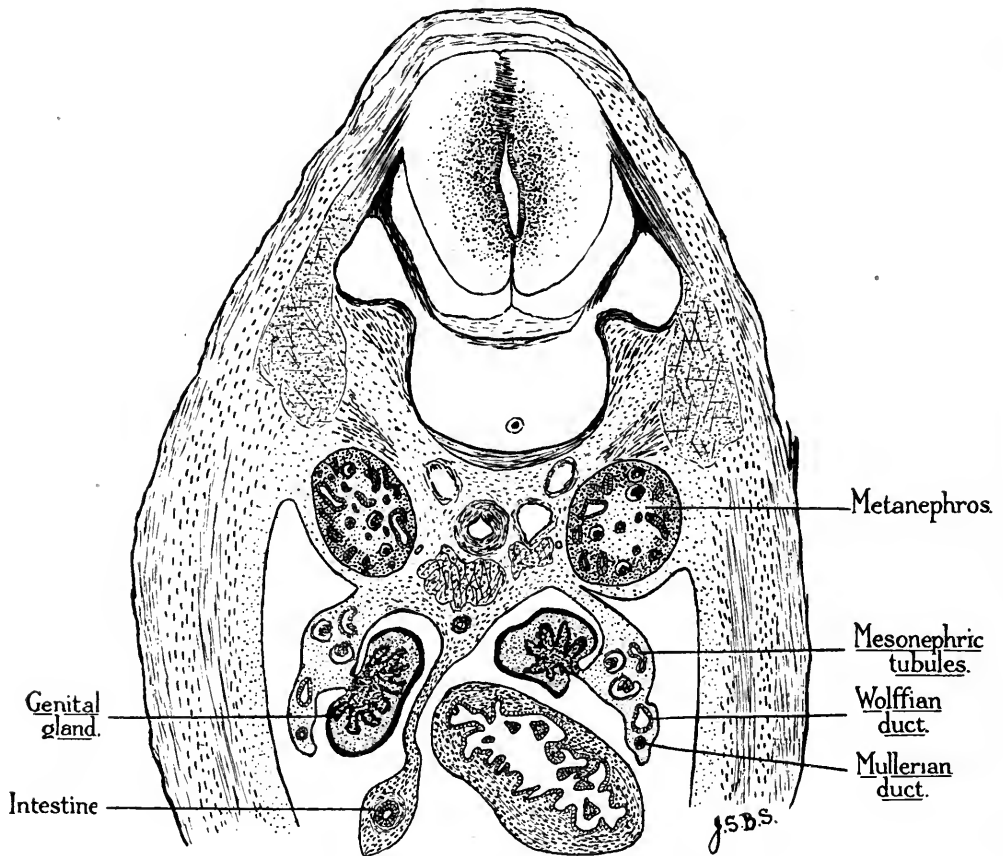


FIG. 3.—Transverse section of a 27-mm. human embryo.

nephros, become attached to the posterior abdominal wall (Fig. 3) by two folds analogous to mesenteries which have a common base, and persist as the mesovarium and mesosalpinx respectively.

The Wolffian body and duct usually atrophy in the female, but remains are found in the following situations :

(1) *Ep-oöphoron* (parovarium) in the lateral part of the mesosalpinx, representing remains of the Wolffian body and duct.

(2) *Par-oöphoron* in the medial part of the mesosalpinx, representing vestiges of the caudal Wolffian tubules.

(3) A few mesonephric tubules in the region of the hilum of the ovary.

(4) The caudal part of the Wolffian duct may frequently be found near (somewhat nearer than the diagram, Fig. 4, might suggest) the side of the uterus or vagina (duct of Gartner). It is not often noticed because it is embedded in the tissues of the vaginal wall (Wood Jones).

In the 5-mm. embryo there is present an entodermal cloaca which communicates above with the allantois and hind gut, but is closed below by the cloacal membrane which separates it from a depression on the surface of the embryo known as

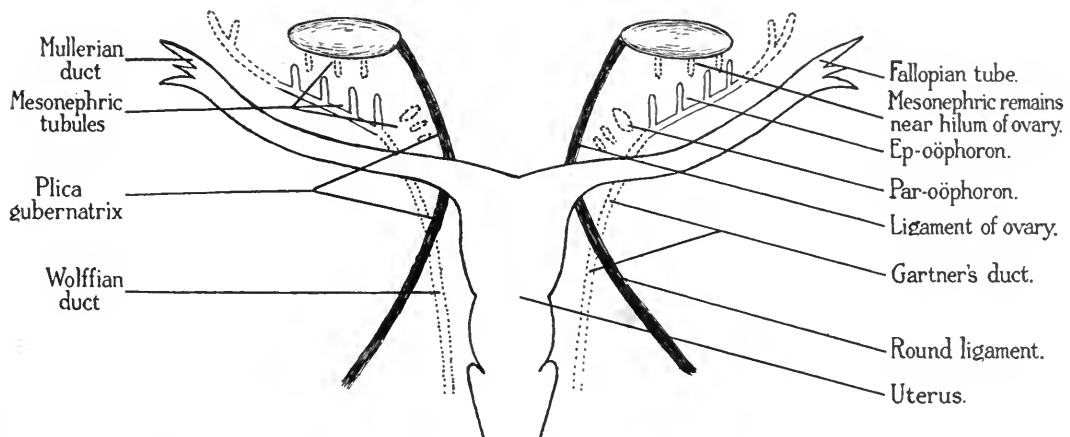


FIG. 4.—Diagram (after Fothergill) to show the arrangement of the internal genitalia after the fusion of the lower parts of the Müllerian ducts to form the uterus.

the ectodermal cloaca. The genital papilla (clitoris) is developed at the anterior limit of the cloacal membrane. The entodermal cloaca is soon subdivided, by the urorectal septum, into an anterior or urinogenital part into which the Wolffian and fused Müllerian ducts open, and a posterior or rectal part which is continuous with the hind gut. The cephalic portion of the urinogenital sinus becomes the bladder whereas the caudal part forms the urethra.

The rectum soon communicates with the exterior by the breaking down of the posterior part of the cloacal membrane, and, immediately after, the urinogenital sinus similarly opens on the surface behind the genital papilla, but in front of the anus. As previously stated, the vagina is formed by a downgrowth from the fused Müllerian ducts. The vagina of the 8.5-cm. embryo has a lumen, but about the middle of the fourth month it becomes occluded again by cells produced by the proliferation of the *caudal extremities of the Wolffian ducts* where they form the

Wolffian bulbs (Berry Hart). The central cells break down to reform the lumen, but the peripheral ones remain as the hymen.

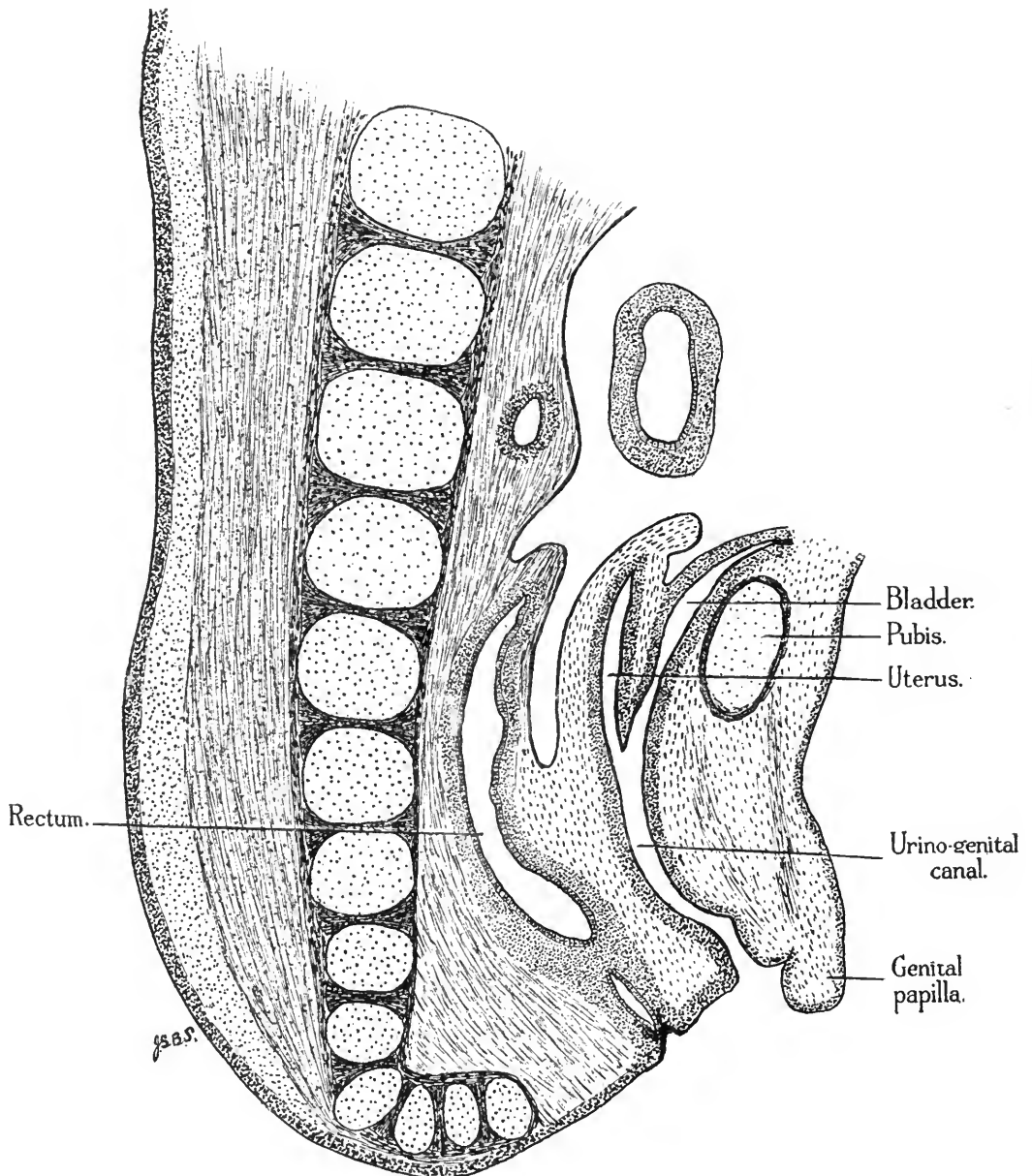


FIG. 5.—Sagittal mesial section of the hind end of a 35-mm. human embryo (from a section lent by Prof. Wood Jones). At this stage the rectum is formed, but the uterus and bladder communicate with the exterior by means of the urino-genital canal.

Soon after the appearance of the genital papilla two ridges are seen on the surface of the embryo, which extend from the papilla backward, one on each side of

the middle line. These ridges, which are known as the inner genital folds, form the labia minora. Alongside each of these a broader and more rounded eminence appears to form the outer genital fold, which becomes the labium majus.¹

At birth the uterus and bladder are both abdominal organs, and reference to Fig. 6 will show the marked difference from the adult in the relative size of the cervix and body of the uterus.

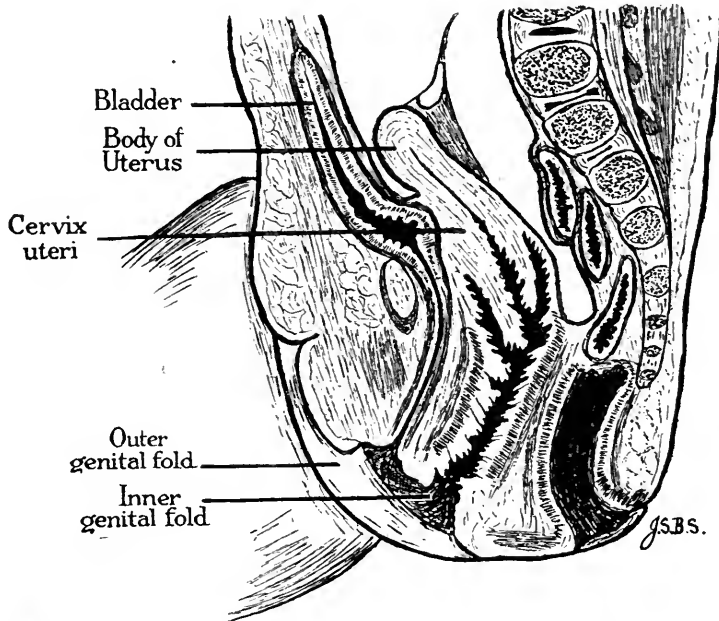


FIG. 6.—Median sagittal section of the female pelvis at birth. Note that the bladder and uterus at this stage are abdominal organs and that the cervix forms the greater part of the uterus.

II. THE ANATOMY OF THE ADULT FEMALE BONY PELVIS AND THE MUSCLES FORMING THE PELVIC DIAPHRAGM

The *pelvis*, formed by the ossa innominata, sacrum, and coccyx, is divided by the pelvic brim into an upper expanded part (false pelvis) and a lower basin-shaped part (true pelvis). After a consideration of its contents it will be obvious that the true pelvis is the one of greater clinical importance.

The pelvic brim, or inlet of the true pelvis, in the female is more or less oval in shape, and is formed by the promontory, sacro-iliac articulation, ilio-pectineal line, and symphysis pubis. Three measurements of the inlet are in constant use: the true conjugate diameter which is the measurement from the sacral promontory

¹ For the morphology of the external genitalia, see Wood Jones, *Lancet*, April 11 and 18, 1914 pp. 1019 and 1099; also May 29, 1915, p. 1113.

to the upper border of the symphysis pubis, the transverse diameter or greatest breadth, and the oblique diameter measured from the sacro-iliac joint of one side to the ilio-pectineal eminence of the other. In the erect posture the true conjugate forms an angle of 60 degrees with the horizontal, and the long axis of the vagina and urethra runs parallel to it, whereas that of the uterus is almost at right angles to it.

The pelvic outlet is bounded by the coccyx, great sacro-sciatic (sacro-tuberous) ligament, ischial tuberosity, and the ischial and pubic rami. Its shape is therefore

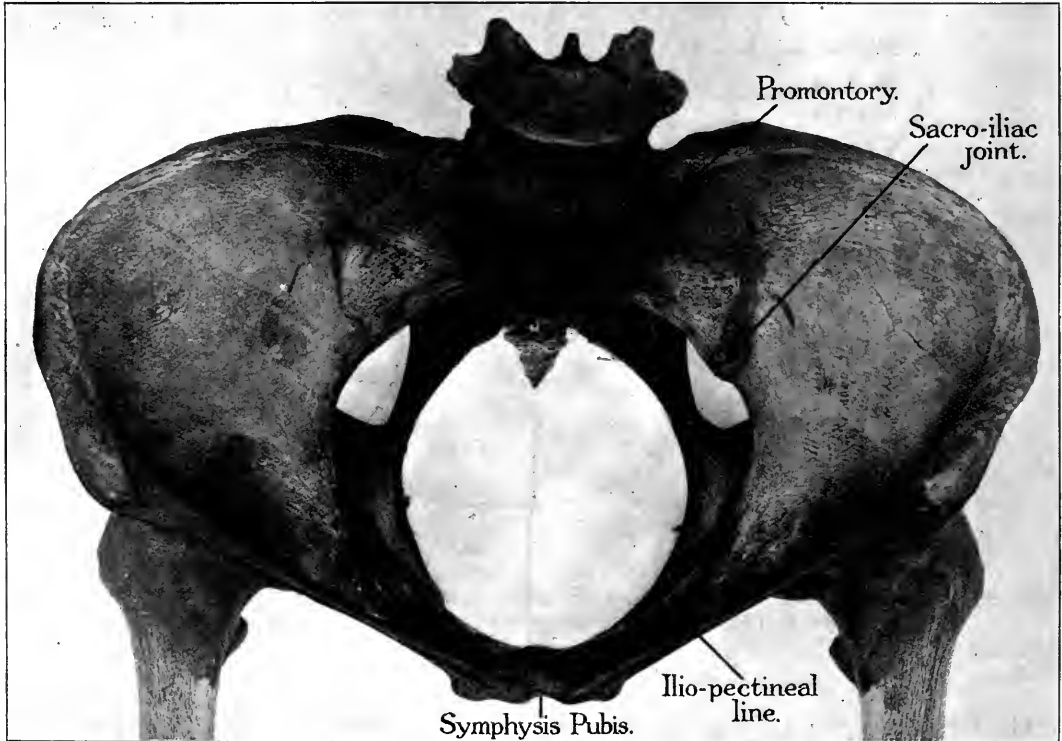


FIG. 7.—Photograph of the inlet of the female pelvis.

irregular and its antero-posterior and transverse diameters are more nearly equal than those of the inlet, but this opening is largely closed by the muscles which form the pelvic diaphragm. The two measurements of the outlet usually studied are: the antero-posterior, from the tip of the coccyx to the lower border of the symphysis pubis, and the transverse, between the medial borders of the posterior part of the ischial tuberosities. The cavity of the true pelvis is deeper behind in the region of the sacrum and coccyx than in front close to the pubic symphysis and arch.

The pelvic axis runs through the centre of the planes of the inlet and the outlet and is approximately parallel to the curve of the sacrum and coccyx. The unim-

pregnated uterus, the empty bladder, the rectum, and coils of the pelvic colon or small intestine are normally found within the cavity of the true pelvis (Fig. 9).

The Pelvic Diaphragm.—The pelvic diaphragm is a composite structure formed, on each side, by three muscles (pubo-coccygeus, ilio-coccygeus, and ischio-coccygeus) which have become modified with the change from the pronograde to the erect position to form a muscular floor for the pelvic cavity. The pubo-coccygeus and ilio-

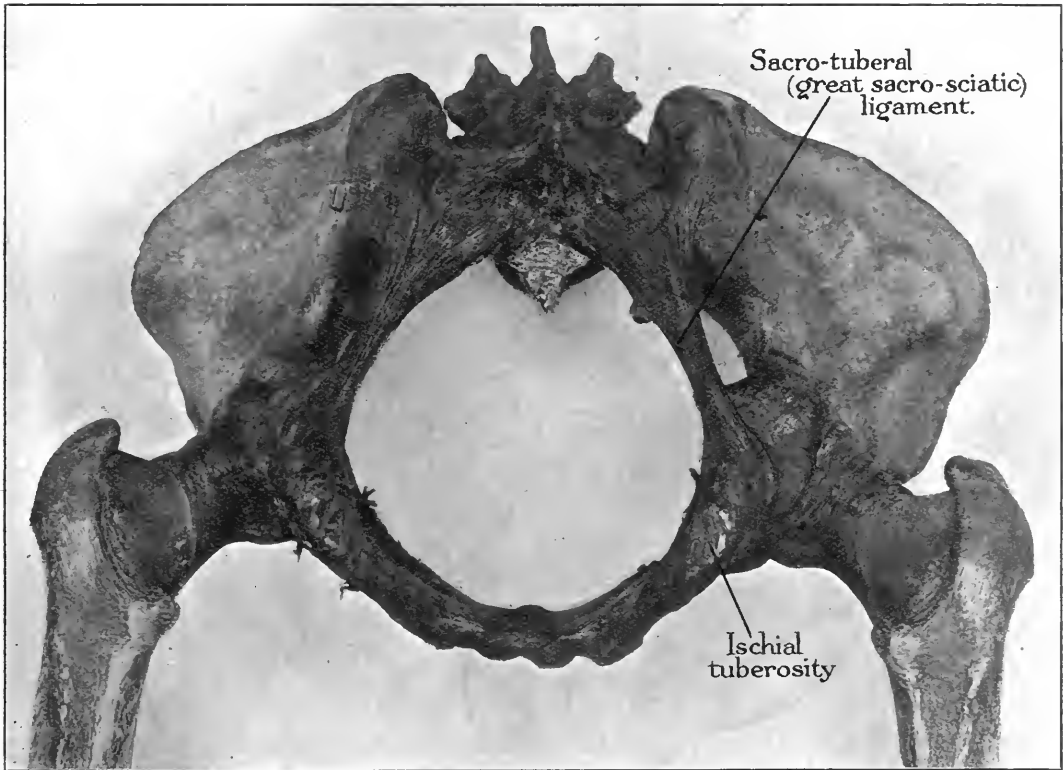


FIG. 8.—Photograph of the outlet of the female pelvis.

coccygeus, which may be blended to form one muscular sheet, or may be more or less completely independent the one of the other, are usually considered together in descriptions as the *levator ani muscle*.

For the correct understanding of the anatomy of the pelvis it is essential to get a clear idea of the nature, relations, and function of the levator ani muscle. At a time when most writers are either greatly exaggerating or unduly minimizing the importance of this muscle, it is more than ever desirable that we should form a just appreciation of its nature.

The ilio-coccygeus is subject to great variation ; and in the majority of cases,

especially in the female, is of little importance. In fact, in many instances, it is reduced to a thin sheet of membrane from which all muscular tissue has practically disappeared. The pubo-coccygeus, however, is a constant and well-developed band of muscle which forms a sling-like connection between the body of the pubes and the

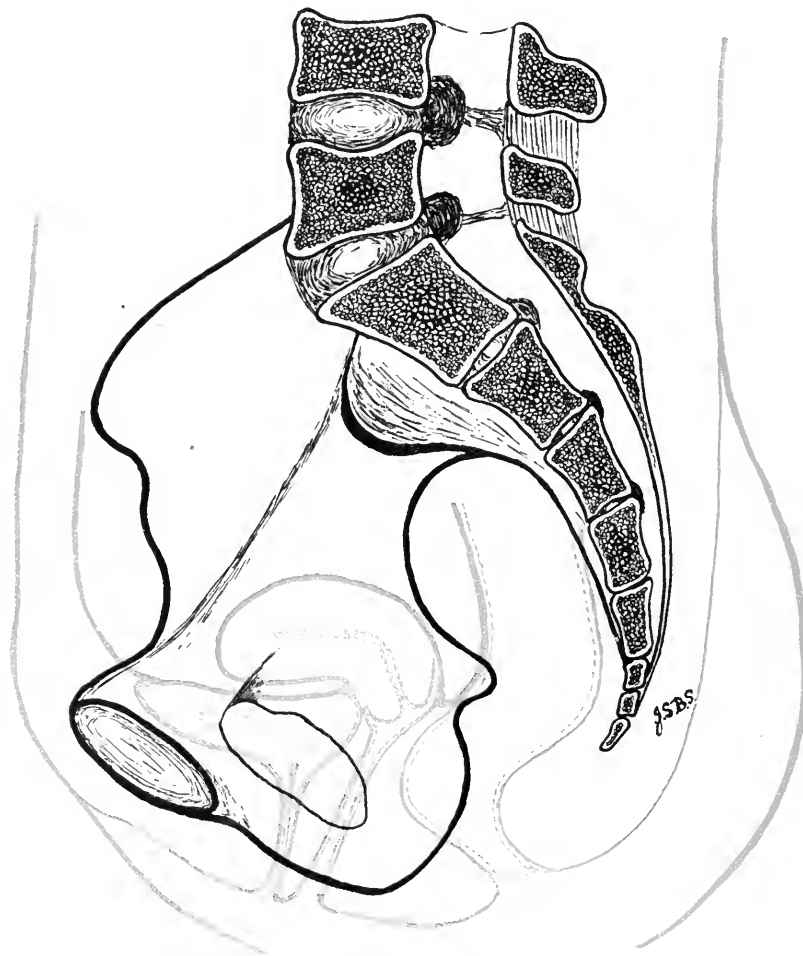


FIG. 9.—Diagram to show the relation of the pelvic viscera to the bony pelvis in the adult female.

coecyx and sacrum. With its fellow of the opposite side it performs the important function of acting as a powerful sphincter of the rectum (upper end of anal canal), vagina, and to a slight degree also of the urethra. In addition to this the muscle is attached to the vagina, base of the bladder, and upper part of the urethra, so that it can assist in holding these structures in position. In this connection, however, it cannot be too strongly emphasized that the levator ani is neither the chief nor even a

necessary means of support of the vagina and uterus; on the other hand, it is not wholly without importance.¹

It is attached anteriorly to the posterior surface of the body of the pubes along an oblique line, which proceeds from the neighbourhood of the lower end of the symphysis to the supero-medial angle of the obturator foramen. From this origin the broad band of muscle proceeds downward and backward, in close contact laterally with the obturator internus muscle (compare Figs. 10, 11, and 29) and medially

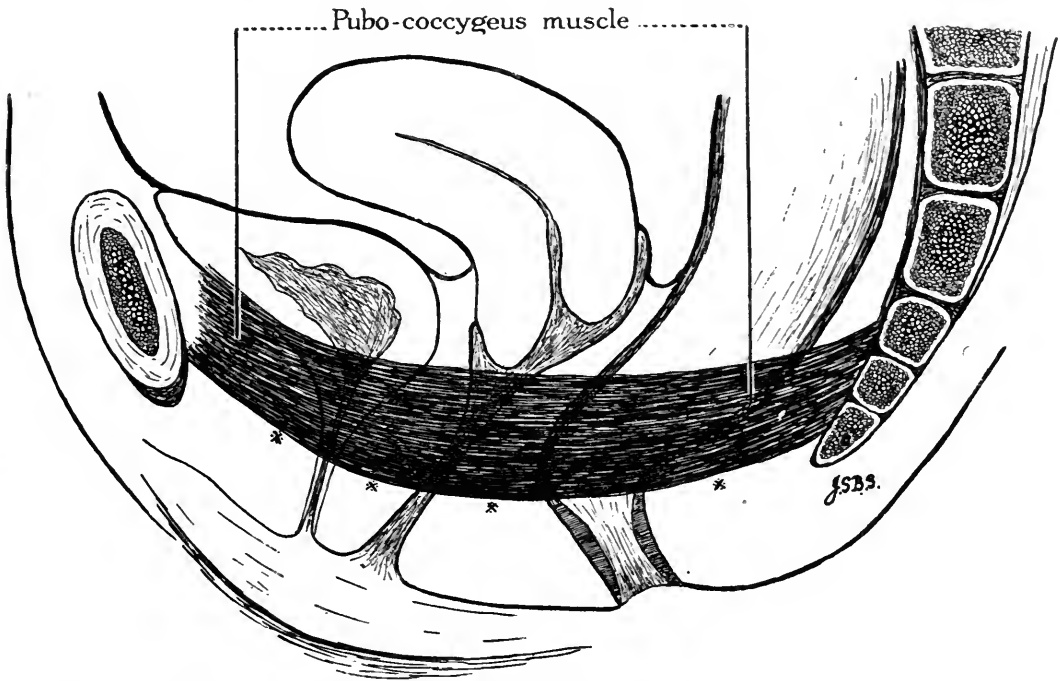


FIG. 10.—Diagram to show the relation of the medial (* *) edge of the pubo-coccygeus muscle to the urethra, vagina, and rectum.

with the tissue around the base of the bladder and urethra, and subsequently with the parametric matrix of the vagina; while anteriorly its inferior border fills up the interval between these structures and the triangular ligament.

A certain number of fibres of the muscle, and especially of its sheath, become connected with the triangular ligament and the dense mass of connective tissue which forms a solid matrix around the upper part of the urethra and the vagina.

As the pubo-coccygeus passes the rectum it flattens the tube so that its lateral walls become applied the one to the other and the lumen is converted into an antero-

¹ See especially the articles by Elliot Smith and Derry, *Journ. Anat. and Phys.*, 1908, vol. xlii.; and also Peter Thompson in the same *Journ.*, 1901, vol. xxxv.

posterior slit. This approximation of the walls of the lower rectum forms the upper portion of the so-called anal canal.¹ The pubo-coccygeus muscle thus constitutes a most powerful rectal (or anal) sphincter. Immediately above the muscle the rectal wall is free from its support and is distended to form the ampulla.

The ischio-coccygeus (or coccygeus) is often entirely aponeurotic, and its consideration is not of the same importance as that of the levator ani. It arises from the ischium and is inserted into the lateral aspect of the coccyx and lowest piece of the sacrum.

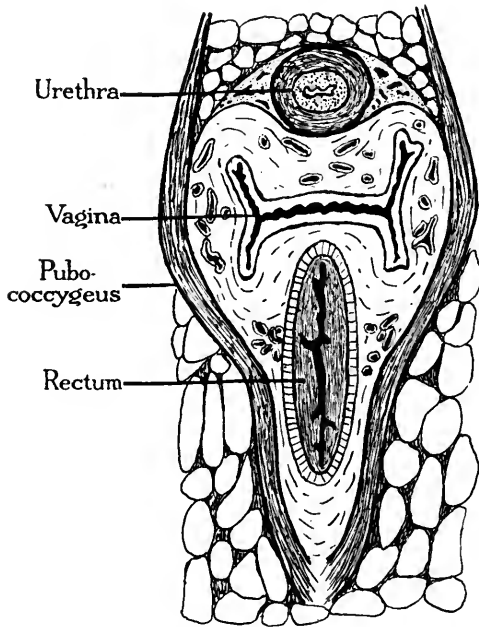


FIG. 11.—Horizontal section (after Henle) to show the relation of the levator ani (pubo-coccygeus) to the urethra, vagina, and rectum. Figure 10 explains the plane in which this section was cut.

III. THE ANATOMY OF THE EXTERNAL FEMALE GENITAL ORGANS AND THE SUPERFICIAL PERINEAL MUSCLES.

The *external genitalia* project slightly on the surface and extend from the front of the symphysis pubis, downward and backward between the thighs, to a point rather more than an inch in front of the anus. As Wood Jones² has recently pointed out, much confusion has arisen owing to the conflicting use of the numerous names which have accumulated for structures in this region, with the result that there is great discrepancy amongst authors.

Consequently it becomes necessary for the present writers to state, so far as possible, the exact limits of the parts indicated by the terms adopted.

The *pudendal cleft* is bounded by two folds on each side, the outer and larger one being the labium majus and the inner one the labium minus.

The *labia majora* are represented by two prominent longitudinal folds of skin and subcutaneous tissue which together almost surround the cleft. They are most prominent about midway between their anterior and posterior extremities: they merge in front into the mons veneris, and behind into the tissue surrounding the posterior limit of the opening. The inner surface of the folds resembles mucous membrane and exhibits numerous sweat glands, whereas the outer surface has the typical appearance of skin, and after puberty is thickly covered with hair.

¹ Henle, *Anatomie des Menschen*, 1888.

² Wood Jones, *Journ. Anat. and Phys.*, 1913-14, vol. xlviii, p. 73.

The *labia minora* lie between the outer folds and are formed of more delicate skin in which are also found a large number of sweat glands. They arise anteriorly, according to their morphology, from the inferior surface of the clitoris, their apparent continuity with the prepuce being secondary (Wood Jones). Posteriorly they merge gradually into the surrounding tissue without uniting.

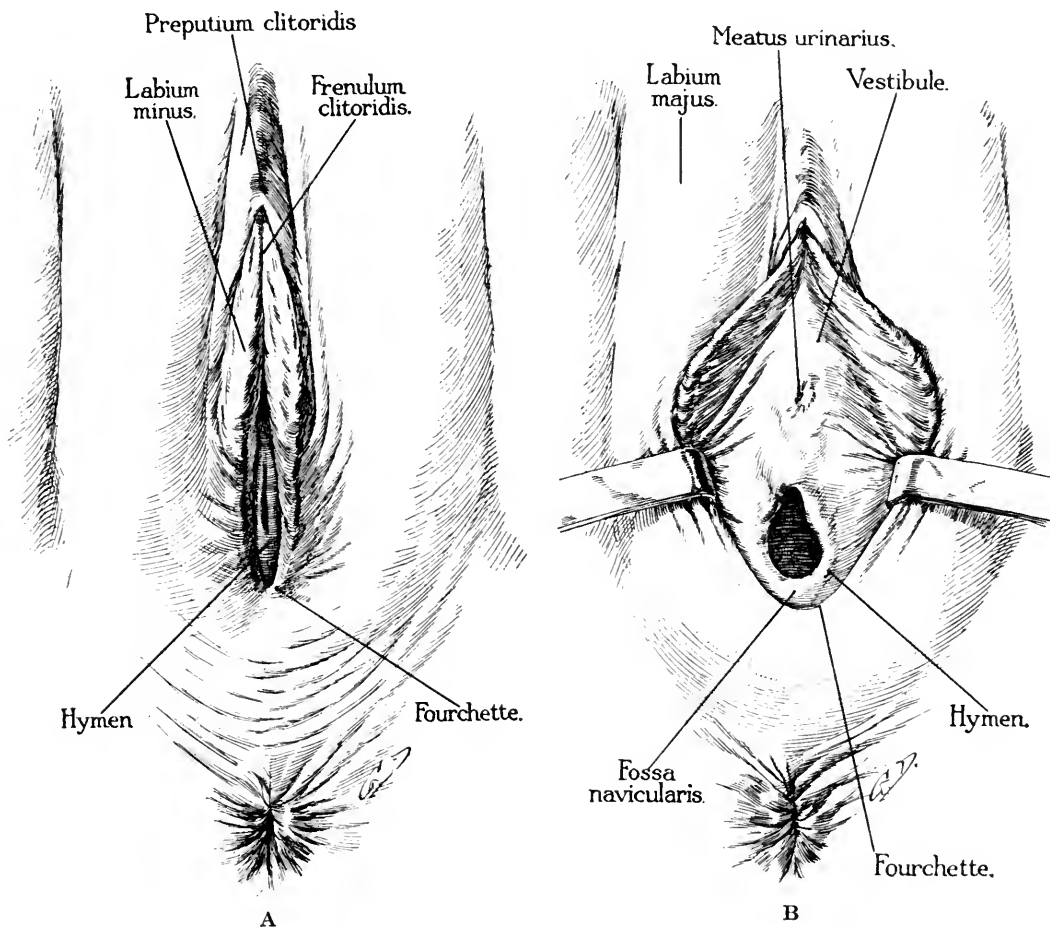


FIG. 12.—A, The virgin vulva. B, The same, after separating the labia. (After Eden.)

The *mons veneris* is a prominence produced by a subcutaneous collection of fat in front of the symphysis, and is covered at puberty with hair similar to that on the outer surfaces of the labia majora.

The *vestibule* is the space bounded in front by the clitoris, laterally by the labia minora and deeply by the hymen. The orifices of the vagina, the urethra, and the ducts of Bartholin's glands open into this space.

The *urethral orifice* is situated about one inch behind the glans clitoridis, and opens into the vestibule.

Bartholin's glands lie immediately lateral to the vaginal wall and their ducts open into the vestibule just in front of the hymen.

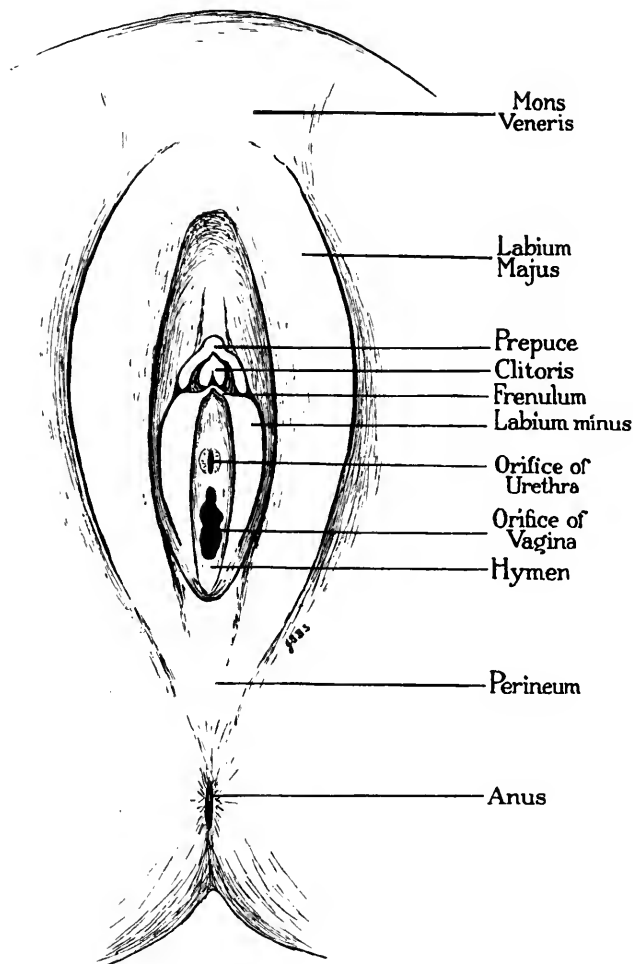


FIG. 13.—Diagram of the female external genital organs represented with the labia majora and minora widely separated.

The *fourchette* is the anterior limit of the perineum, and forms one boundary of that posterior part of the pudendal cleft to be described as the fossa navicularis.

The *fossa navicularis* has now come to be described as the hind part of the pudendal cleft; the part which intervenes between the fourchette and that portion of the hymen which lies behind the orifice of the vagina.

The *hymen* is a fold of mucous membrane which forms the base of the vestibule

and the fossa navicularis. The fold, like the perforation (vaginal orifice) in it, is variable in appearance, and as a rule is only seen in the virgin.

The *bulb of the vestibule* is homologous with the corpus spongiosum of the male ; but, owing to the developmental differences in the sexes, is almost completely divided in the female into two lateral parts which partially surround the entrance to the vagina. The two halves of the bulb join above the urethra, to form the *pars intermedia*, and extend into the clitoris to form the glans.

The *clitoris* is homologous with the penis, and, like it formed by the two corpora

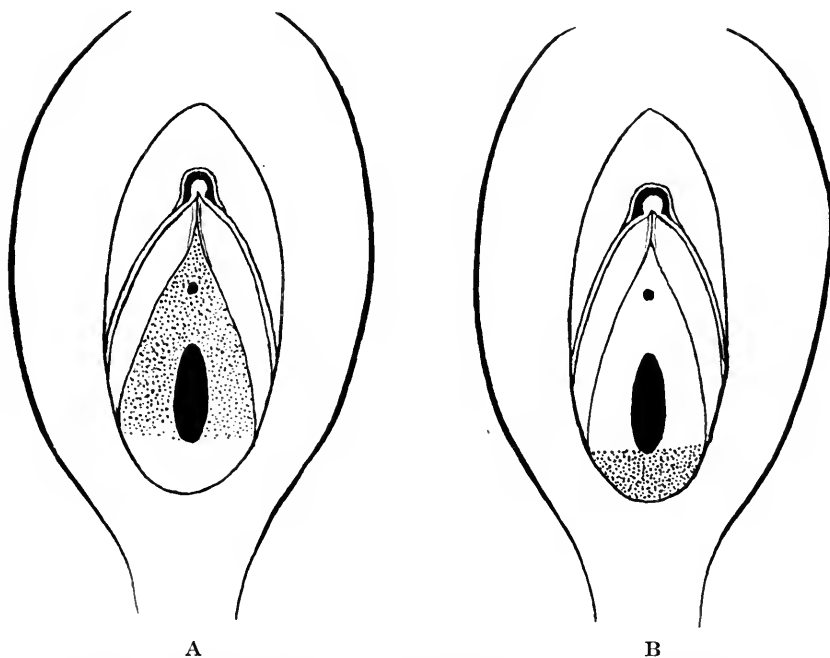


FIG. 14.—Two diagrams (after Wood Jones) to represent the exact extent (shown by stippling) of A, the vestibule, and B, the fossa navicularis.

cavernosa, composed of erectile tissue. It is situated at the apex of the vestibule, and is covered above by a fold of skin (prepuce), which gains secondary attachment to the labia minora, and below by the frenulum which is attached to the same folds. Although hidden, the small glans is usually uncovered, highly sensitive and vascular, and formed by the anterior fused part of the bulbs of the vestibule. Laterally the corpora cavernosa diverge to form the crura, which are attached to the pubic arch.

The *perineum* is, strictly speaking, the space between the fourchette in front and the anus behind ; but unfortunately the term is usually employed in a wider anatomical sense, and is used to describe the whole space which corresponds to the pelvic outlet.

The *perineal body* is the pyramidal mass of muscular and fatty tissue which intervenes between the vagina and the anal canal (compare Figs. 15 and 19). It is essential not merely as a means of separating the anal and vaginal canals, but also for contributing to the integrity and support of these structures, and is of importance

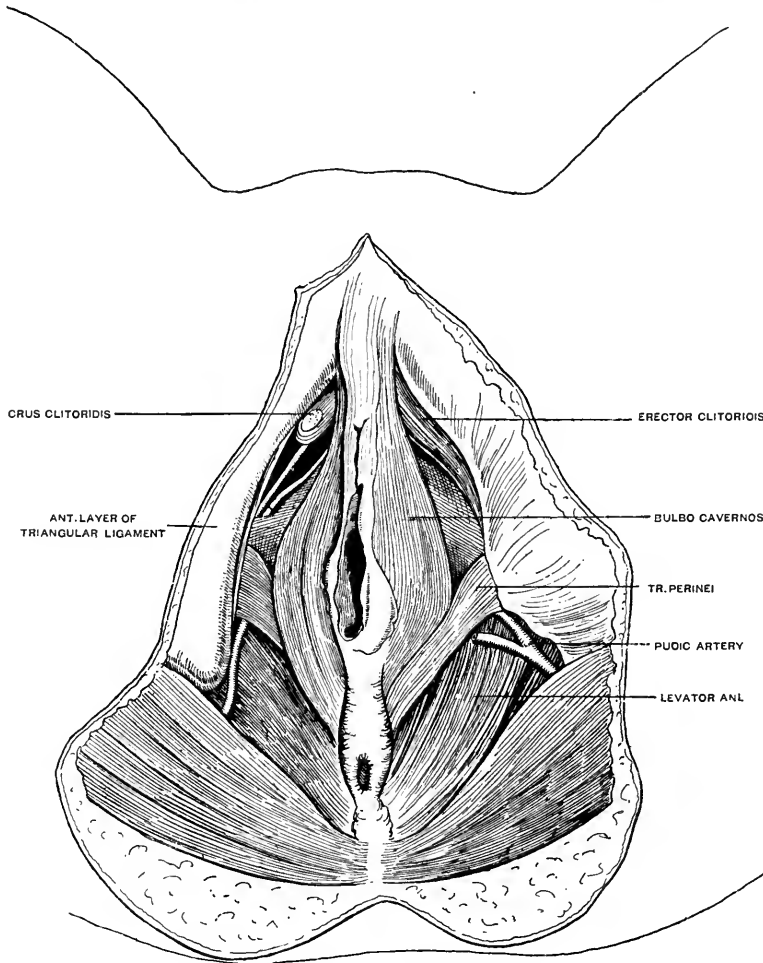


FIG. 15.—Perineal region.

in that it acts as a brace for some fibres of the levator ani and many of the superficial perineal muscles.

The Perineal Muscles.—For the study of gynaecology only a short account is necessary of the muscles which form the pelvic floor, as it has now been conclusively proved that they furnish quite a negligible support to the uterus and pelvic contents.

This group of muscles is often systematically divided into a superficial set consisting of the superficial anal sphincter, vaginal sphincter, erector clitoridis, and

superficial transverse perineal muscles ; and a deep set composed of the deep anal sphincter, urethral sphincter, and deep transverse perineal muscles.

The *superficial anal sphincter* surrounds and acts as a sphincter of the anus. Its superficial fibres arise from the coccyx and ano-coccygeal body, and are inserted into the perineal body, whereas its deeper fibres encircle the lower part of the anal canal.

The *vaginal sphincter* (bulbo-cavernosus) contracts the orifice of the vagina, and also compresses the bulb of the vestibule and dorsal vein of the clitoris, and thus assists the erector clitoridis. It arises from the perineal body and its fibres pass on each side of the genital cleft, in close relation to the lateral surface of the bulb of the vestibule, to gain insertion partly into the corpus cavernosum of its own side, and partly into the dorsal surface of the clitoris.

The *erector clitoridis* (ischio-cavernosus) acts by compressing the crus against the ischium, and consequently arises from that part of the bone which lies immediately beyond the termination of this erectile tissue, and its fibres pass forwards over the crus to be inserted into the junction of the crus and corpus cavernosum of its own side.

The *superficial transverse perineal muscles* together fix the perineal body. They arise near the ischial tuberosity and their fibres pass medially from this origin to their insertion into the perineal body (Fig. 15).

The *deep (or internal) anal sphincter* is stronger than the superficial one and encircles the anal canal immediately above it.

The *urethral sphincter* is composed of more superficial fibres, which surround the urethra near its orifice, and deeper fibres, which pass across the pubic arch between the urethra and the vagina.

The *deep transverse perineal muscles* are usually ill-defined and consist of a few scattered muscular fibres which arise from the inferior rami of the ischial bones and are inserted into the posterior vaginal wall.

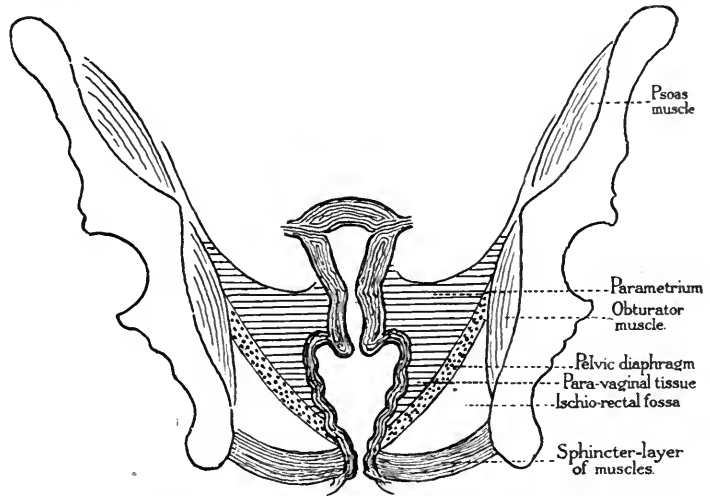


FIG. 16.—Transverse section (diagrammatic) showing the relation of the uterus and vagina to the pelvic diaphragm and the ischio-rectal fossa.

The Ischio-rectal Fossa.—The pyramidal space between the anal canal and the ischium is known as the ischio-rectal fossa.¹ As the space is filled with fat, a soft displaceable material, it permits distension of the anal canal during defaecation and of the vagina during the second stage of labour. The fossa is bounded medially by the levator ani and its sheath of connective tissue, which together cover the anal canal (Fig. 17). The lateral boundary is formed by the ischium and the fascia

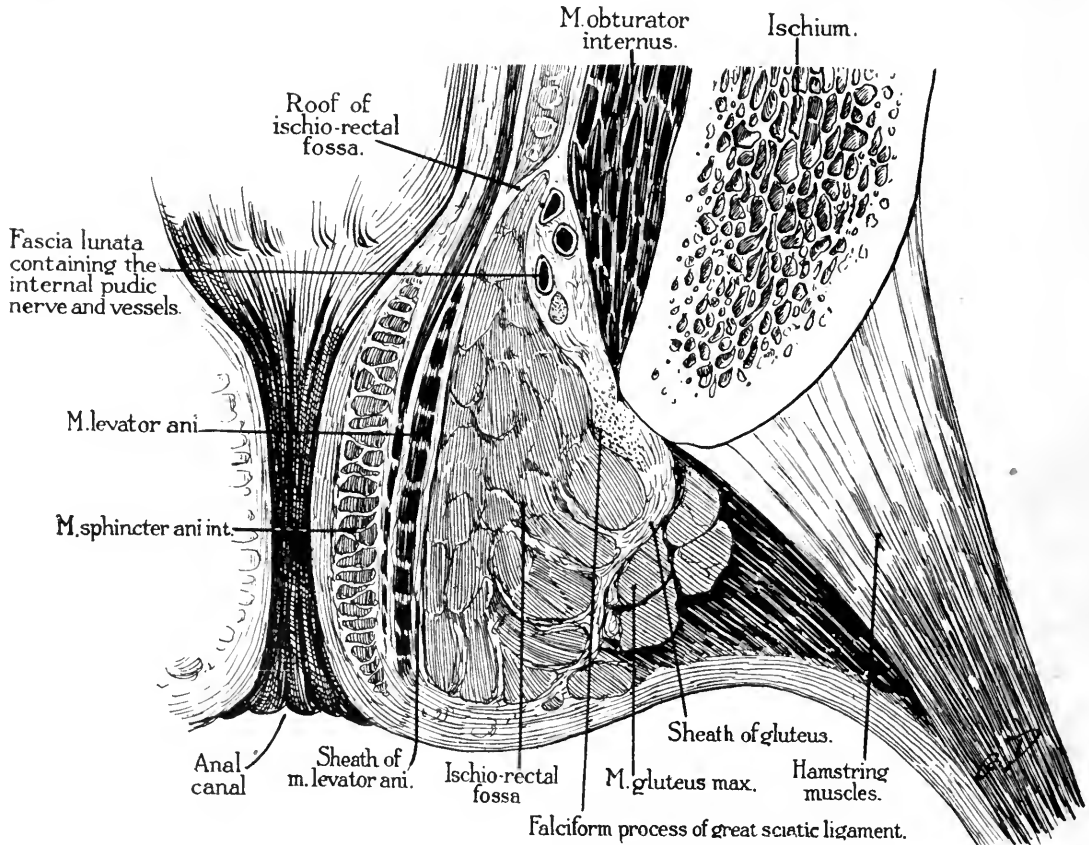


FIG. 17.—A transverse section (in the line of the anal canal) through the ischio-rectal fossa (Elliot Smith).

lunata (the connective tissue collected around the internal pudic nerve and vessels to form an imbedding matrix), the gluteus maximus muscle and the great sacro-sciatic ligament; it extends as far forward as the triangular ligament.

The internal pudic vessels and nerve pass forward through the space, immediately above the edge of the great sciatic ligament and the attachment of its anterior

¹ For a fuller account of the boundaries of the ischio-rectal fossa, see Elliot Smith, *Journ. Anat. and Phys.*, 1908, vol. xlii. pp. 200-204.

extension (falciform process) to the ischial tuberosity (Fig. 17). The fibrous matrix of the internal pudic (or, as it is now often called, pudendal) structures is in apposition with the medial aspect of the obturator internus muscle, with the lower part of the sheath of which it is intimately fused. Below the muscle this matrix (fascia lunata) is attached to the great sciatic ligament or the ischium. Above it is attached by a narrow roof-membrane (Fig. 17) to the fascia covering the rectal wall. Although this membrane may easily be destroyed during a dissection of the ischio-rectal fossa, its importance is clearly shown in cases of *fistula in ano* by examination of the position of the internal aperture which is found to lie below the point of attachment of this septum to the medial wall of the fossa. Above the roof of the ischio-rectal fossa only a narrow space separates the rectum from the obturator internus (Fig. 17) and, as there is no efficient barrier between the tissues in this space and the pelvic connective tissues, it is clear that the thin membrane forming the roof of the fossa is the only real obstacle to the extension of an ischio-rectal abscess to the pelvis. It is important to remember that the internal pudic vessels are the guide to the situation of the roof.

The ischio-rectal fossa is closed anteriorly by the approximation of its walls and the attachment of its roof-membrane to the base of the triangular ligament and the sheath of the transverse perineal muscles (Fig. 16).

IV. THE ANATOMY OF THE CONTENTS OF THE FEMALE PELVIS, INCLUDING A DESCRIPTION OF THE PELVIC PERITONEUM

It will be most convenient to study the internal female genital organs in detail, briefly referring in the course of this description to the salient points in the anatomy of the bladder and urethra, which lie in front, and the rectum and anal canal behind.

Ovary.—This organ is attached to the posterior aspect of the broad ligament by a fold of peritoneum, known as the mesovarium, and usually lies in contact with the lateral wall of the true pelvis, where its exact position can be defined only in nulliparae. In women who have not borne children it lies almost vertically in the shallow ovarian fossa, which is bounded above by the external iliac artery and posteriorly by the internal iliac artery and the ureter. The lateral surface is separated from the obturator vessels and nerve, as they cross the ovarian fossa, by the peritoneum covering the pelvic wall. The medial surface is almost hidden by the lateral extremity of the Fallopian tube, and their exact relationship will be considered with the latter structure.

The anterior border is attached to the posterior layer of the broad ligament by the mesovarium, and consequently is often called the attached border or hilum, as

the ovarian vessels pass to and from the gland in the mesovarium. The posterior or free border is directed backward toward the ureter.

The superior extremity (or tubal pole on account of attachment of the ovarian fimbria to it) appears to be supported by a fold of peritoneum, which is really the lateral part of the upper free border of the broad ligament beyond the extremity of the Fallopian tube. This fold, which has been unfortunately described as the suspensory ligament of the ovary but is better designated the *infundibulo-pelvic fold*, contains the ovarian vessels as they pass into the broad ligament. The

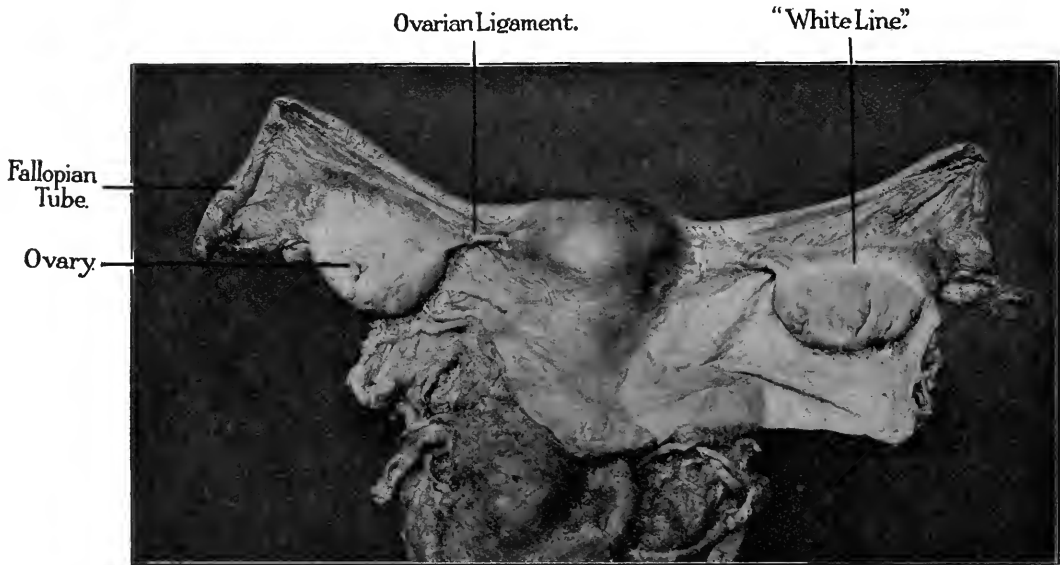


FIG. 18.—Photograph of the posterior surface of the uterus and broad ligaments (which have been outstretched on both sides).

inferior extremity (or uterine pole) is connected with the uterus by that portion of the plica gubernatrix (see p. 2) which forms the ligament of the ovary.

The ovary is not covered by peritoneum, which extends from the mesovarium only just far enough to reach the ovary, where its edge corresponds to the so-called "white line," but occasionally the ovary is found in a peritoneal pouch, as in certain mammalian forms. The pouch in women, when present, is usually formed by adhesions between the broad ligament and the peritoneum covering the pelvic wall. It has recently been claimed that the existence of such a pouch may afford the explanation of certain clinical manifestations.¹

The gland varies considerably both in appearance and size during life. In early life it is smooth and oval, later it is relatively larger and more rounded, whilst its

¹ E. Reynolds, *Boston Med. and Surg. Journ.* vol. clxviii., 1913.

surface becomes more and more scarred owing to the repair after rupture of the Graafian follicles. After the menopause it becomes atrophic, and is represented usually by a small, firm, irregular mass which is composed almost entirely of fibrous tissue.

Fallopian Tubes.—The Fallopian tubes are found on the floor of the pelvis, lying on each side of the uterus, and form a communication between the uterine cavity medially and the general peritoneal cavity laterally. This communication is of physiological and pathological importance. Each tube lies in the upper free border of the broad ligament, which is quite lax, and is covered by peritoneum for about $\frac{5}{6}$ of its circumference, the remaining lower $\frac{1}{6}$ resting on the connective tissue between the layers of the ligament.

At first the tube extends laterally from the lateral uterine angle to the inferior extremity of the ovary, where it changes its direction and now passes upward along the anterior border, then backward across the medial surface, and finally downward to the inferior extremity of the gland. From its varying calibre the tube is best divided into four parts: First, a medial, narrow, *interstitial* part represented by the portion actually in the uterine wall; secondly, a constricted part or *isthmus* extending from the uterus to the ovary; thirdly, a dilated part or *ampulla*, in contact with the medial surface of the ovary; and fourthly, the funnel-shaped *infundibulum* which leads up to the abdominal ostium and is surrounded by the finger-like fimbriae. The calibre of the isthmus is such as to admit only a bristle, whilst the ampulla will admit the uterine sound.

The hydatid of Morgagni, derived from the Müllerian duct, is attached to the Fallopian tube or one of the fimbriae.

The Fallopian tube is composed of four coats: an incomplete peritoneal covering, a muscular coat consisting of outer longitudinal and inner circular layers, and a remarkably folded mucous membrane, between which and the last mentioned is a thin submucous coat. The mucous membrane is continuous with that of the uterus and is thrown into many longitudinal folds which extend as far as the fimbriated orifice. The lining epithelium is of the columnar ciliated type.

Uterus.—When isolated this organ is pear-shaped and in the virgin exhibits below the centre a constriction or isthmus, which divides it into two parts, the body and cervix. Inferiorly the cavity of the cervix communicates with that of the vagina by means of the external os, whereas above at each lateral angle the cavity of the body communicates with the minute lumen of the interstitial part of the Fallopian tube through the uterine ostium.

The body is triangular in shape. It is flattened antero-posteriorly and is covered

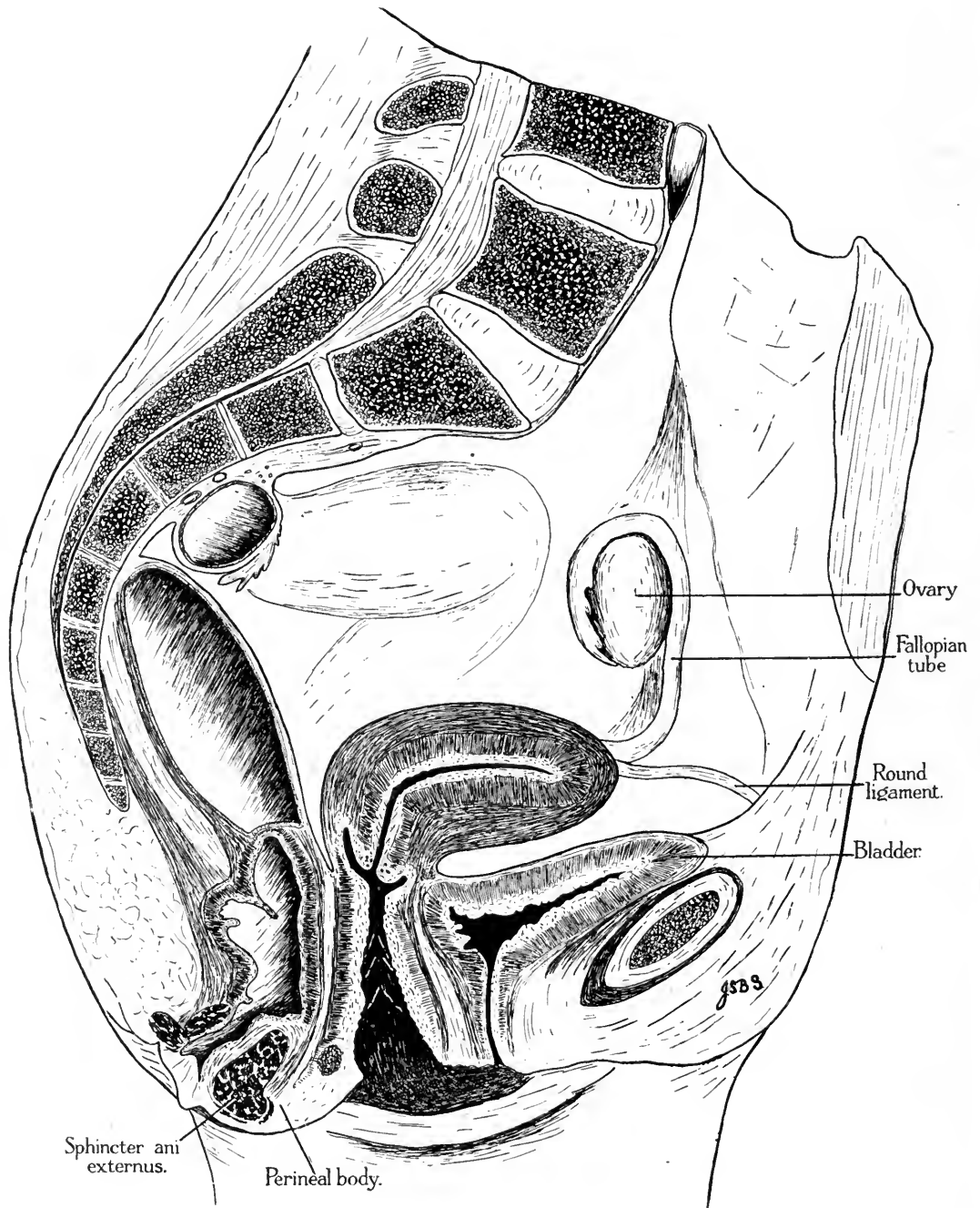


FIG. 19.—Diagram of a sagittal section of the adult female pelvis.

completely posteriorly and almost as far down as the isthmus anteriorly by peritoneum, which is firmly attached to the subjacent muscular coat. The flattening is more pronounced on the anterior surface where the uterus is separated from the base of the bladder by the shallow utero-vesical fossa (Fig. 19), which normally does not contain intestine. The posterior surface is the more convex and is separated from the rectum by the deep recto-vaginal fossa, or pouch of Douglas, which usually contains coils of pelvic colon or small intestine.

Laterally the peritoneum passes off the two surfaces of the uterus to form the broad ligament, and consequently the lateral margins are left bare, but are in relation to the uterine artery as it extends upward alongside the uterus to give off numerous transverse branches of supply. The lateral angle marks the position of the uterine ostium of the Fallopian tube. The round and ovarian ligaments are also attached to the uterus anteriorly and posteriorly, respectively, in this region.

The full rounded superior border is generally distinguished as the fundus, but, strictly speaking, this term includes that portion of the body situated above a line joining the uterine ostia.

The cervix is cylindrical and can be divided into vaginal and supravaginal parts. The vaginal portion is the symmetrical unattached part projecting into the vagina. The supravaginal portion is attached to the bladder anteriorly and to the vagina posteriorly. The anterior aspect of the cervix is devoid of peritoneum and is separated from the neck of the bladder by a small amount of dense connective tissue. The posterior surface is covered by peritoneum and so forms the lower part of the anterior boundary of the pouch of Douglas. Laterally the cervix is fixed by the large mass of vascular connective tissue to be described later as the parametrium. It is important to remember the relation of the ureter, which passes forward to the bladder $\frac{3}{8}$ inch lateral to the external os in the normal adult female. The external os, through which the uterus communicates with the vagina, in the nullipara is a small, rounded, depressed opening encircled by a raised margin which, owing to the apparent oblique invagination of the cervix, appears to form an anterior and posterior lip. After the first confinement the opening is generally represented by a transverse slit and then the two lips are much better defined. The posterior lip is the longer, but, when the uterus is in its normal position, the anterior lip descends to a lower level.

The cavity of the uterus, owing to the thickness of its walls, is comparatively diminutive. The cavity of the body is triangular with the two walls practically in apposition, whereas the cavity of the cervix is spindle-shaped. In nulliparae the junction of the two is marked internally by a slight constriction, the internal os,

which is normally quite indefinite after the birth of the first child. The length of the cavity of the unimpregnated uterus, measured from the external os to the upper limit of the cavity above, is $2\frac{1}{2}$ inches in the normal adult.

The mucous membrane of the cervix shows a number of folds which pass obliquely upward from vertical anterior and posterior folds, and give the appearance designated *arbor vitae*.

The normal adult uterine wall is fully half an inch thick and consists of smooth muscle. The peritoneal coat has already been studied, although it is necessary to emphasize again how adherent this covering is to the subjacent muscle except over the dorsal aspect of the cervix where it may be reflected easily in certain operative procedures. The muscular coat is thick but varies slightly in composition in the two fundamental subdivisions of the uterus: in the cervix there is proportionately less muscle and more connective tissue than in the body. Some of the more superficial muscular fibres extend into the round, ovarian, and utero-sacral ligaments. The mucous membrane consists of a superficial covering of columnar ciliated epithelium lying on a layer of connective tissue which has an embryonic appearance. Just within the external os the epithelium passes into the stratified squamous type seen in the vagina.

Numerous so-called "glands" open on the surface and pass down to the muscular coat; those in the cervical mucous membrane are slightly more complex in structure and, when obstructed, may give rise to small cysts known as the ovules of Naboth.

The uterus is normally in a position of anteversion and anteflexion (Fig. 19), that is to say, the axis of the cervix forms with the axis of the vagina an angle directed forward, and furthermore the flexible body is still more directed forward so that its axis forms an angle with that of the comparatively more rigid and fixed cervix. This position can only be found when the surrounding viscera are empty, as distension of the bladder gradually diminishes anteflexion, and distension of the rectum tends to push the uterus upward and backward.

For gynaecological examination it is essential to realize that posture can influence the position of the uterus. The genupectoral position is particularly advantageous for replacement of the distorted uterus (Fig. 20).

Vagina.—This canal communicates above with the uterus and below with the vestibule, and is about 3 inches long, the posterior wall being about half an inch longer than the anterior. Its axis is parallel to the conjugate pelvic diameter. The canal is broader in the middle than at its extremities, but normally its walls are in apposition. The shorter anterior wall lies in close contact with the neck of the bladder, and below with the urethra which runs downward and forward parallel to

and almost in the substance of this wall. The longer posterior wall above is separated from the rectum by the pouch of Douglas, as about the upper half inch of this wall is covered by peritoneum ; the intermediate part is separated from the

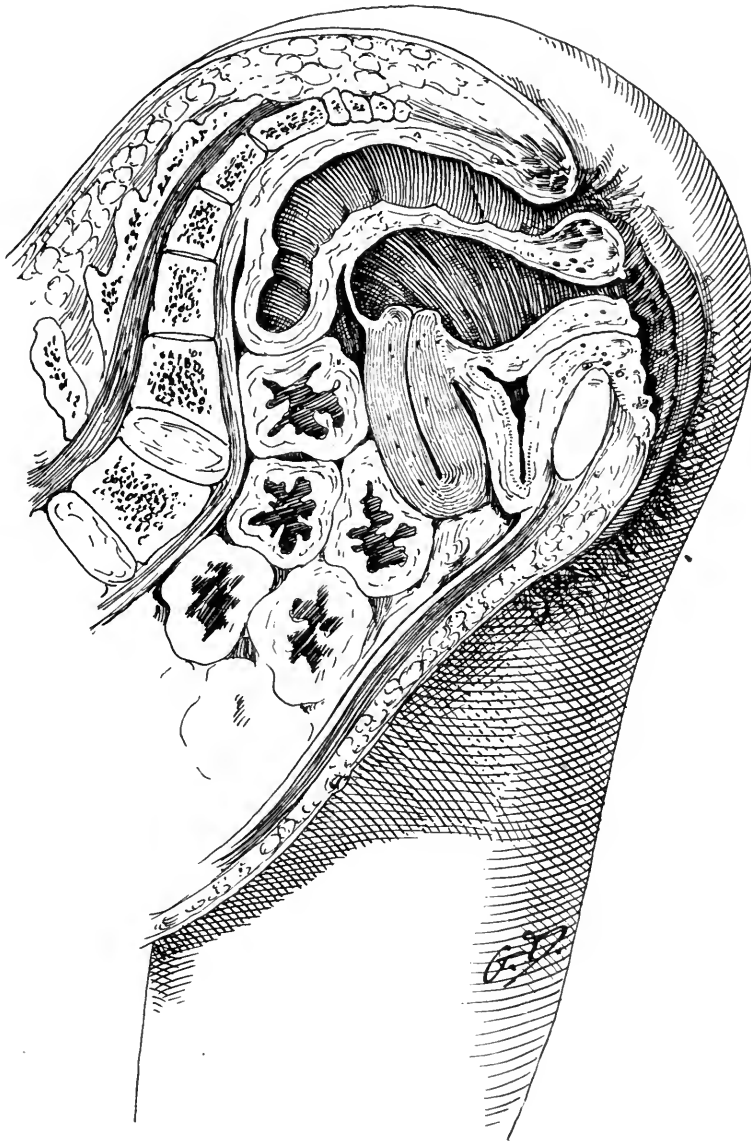


FIG. 20.—Diagram of a median sagittal section to show the influence of gravity upon the pelvic viscera, when the body is in the genupectoral position and the vagina is distended.

bowel by connective tissue and the lowest limit by the perineal body (Fig. 19). Laterally the vagina is embraced by the medial borders of the two pubo-coccygei muscles (Figs. 10, 11, 29, and 30).

Owing to the projection of the vaginal portion of the cervix into the vagina a fossa, which is considerably deeper posteriorly than elsewhere, surrounds this part of the cervix. The fossa is subdivided for descriptive purposes into four parts, named the anterior, posterior, and two lateral fornices. For clinical purposes it is essential to know the structures palpable from the fornices. The anterior fornix will furnish information with regard to the bladder, whereas the posterior enables the gynaecologist to examine the rectal wall, and what is infinitely more useful, the contents of the pouch of Douglas, which is the most dependent point of the peritoneal cavity, and consequently one where free fluid in the peritoneal cavity will accumulate. With a finger in the lateral fornix it is possible to palpate the tube and ovary, the diseased parametrium (Figs. 29 and 30), and in favourable circumstances pathological conditions of the ureter, whilst during pregnancy and certain morbid conditions, pulsation of the uterine artery may be felt.

The vagina is lined by stratified squamous epithelium, which lies on papillae of connective tissue containing some elastic and smooth muscle fibres. External to this lie two layers of unstriated muscle—an inner circular and an outer longitudinal. Only a few glands are present, and the mucous membrane has a structure analogous to that of skin. In nulliparae numerous transverse folds or rugae are seen which run between an anterior and posterior longitudinal fold.

It is of great importance to note that loose connective tissue separates the anterior rectal wall and posterior vaginal wall, and similarly the bladder and anterior vaginal wall.

The Pelvic Peritoneum.—When the peritoneum is followed down the anterior abdominal wall it is seen to be reflected on to the superior surface of the bladder immediately above the symphysis pubis (Figs. 19 and 21). After it has loosely covered this surface of the bladder it passes on to the ventral surface of the uterus, just above the isthmus, to form the shallow utero-vesical pouch. It then covers the fundus, and closely invests the whole dorsal surface of the uterus and upper half inch of the posterior vaginal wall, before it is reflected on to the rectum and sacrum to form the pouch of Douglas. This pouch is bounded laterally by the prominent utero-sacral folds which enclose some smooth muscle fibres.

In the empty condition shallow fossae will be found on each side of the bladder (paravesical) and rectum (pararectal).

If the peritoneum is traced in a sagittal direction to one side of the median plane it is seen to pass over the Fallopian tubes as they extend laterally, so that a loose curtain or fold is formed which extends from each lateral margin of the uterus to the side wall of the pelvis and produces with the uterus an inefficient transverse

septum across the pelvic cavity. This fold on each side, known as the broad ligament, consists of an anterior layer continuous with the peritoneum covering the ventral surface of the uterus and a posterior layer continuous with that covering the dorsal surface. The upper border is free and contains the Fallopian tube, except as it approaches the pelvis where this border really forms the so-called suspensory ligament of the ovary. At the medial, lateral, and inferior borders the two layers diverge to cover the uterus, lateral wall, and floor of pelvis respectively.

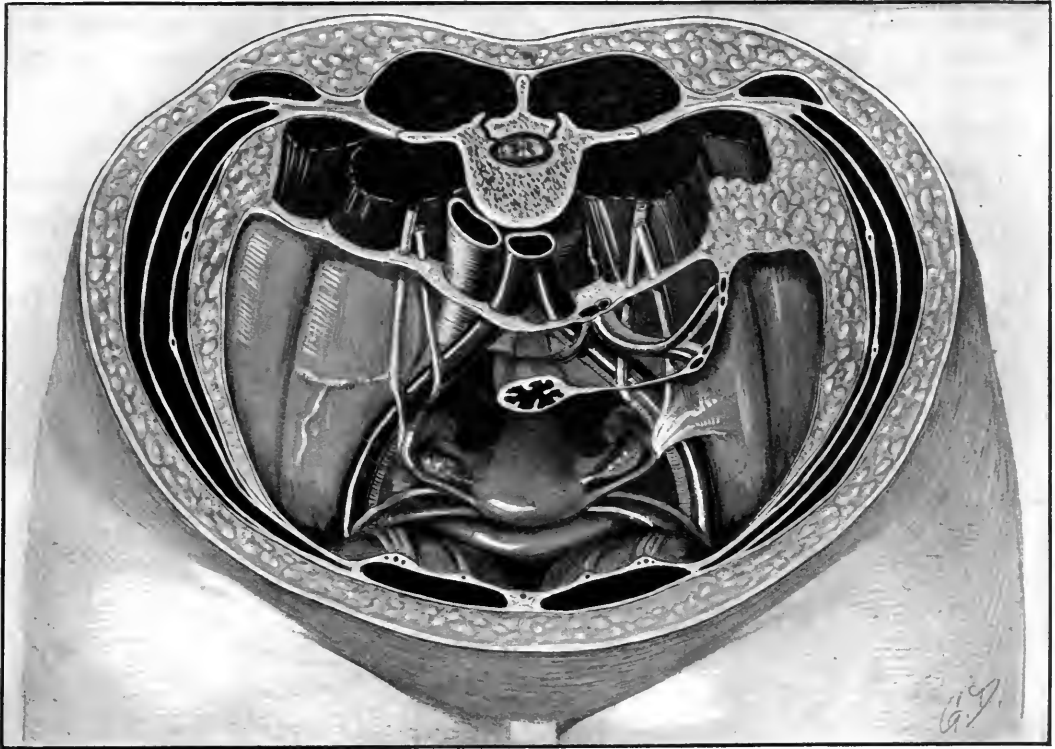


FIG. 21.—Female pelvis and its contents seen from above. (After Waldeyer, *Das Becken*, 1899.)

The ovary is attached to the posterior surface by the mesovarium, which forms one of the three parts of the broad ligament; the remaining portion of the ligament being divided by the ligament of the ovary into an upper part known as the mesosalpinx and a lower part termed the mesometrium.

Between the two layers of the broad ligament the following structures are found (Fig. 22):

- (i.) *Viscera*.—The Fallopian tube.
- (ii.) *Ligaments*.—(a) The round ligament extends from the ventral aspect of

the lateral angle of the uterus forward and laterally in the broad ligament, and then ascends to the internal abdominal ring. After traversing the inguinal canal it is

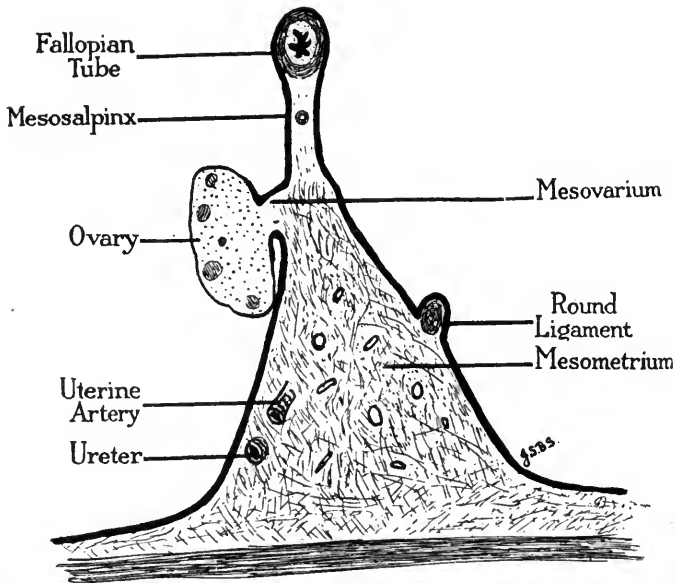


FIG. 22.—Vertical section of the broad ligament through the ovary and mesovarium.

inserted into the subcutaneous tissue in the region of the labium majus. The round ligament is quite lax and contains a variable amount of smooth muscle and usually an artery and some lymphatics. (b) The ligament of the ovary extends from the uterine pole of the gland to the dorsal aspect of the lateral angle of the uterus.

(iii.) *Blood-vessels.*—The uterine and ovarian arteries and veins will be considered in a separate section.

(iv.) *Nerves.*—These are branches from the hypogastric plexus which will be studied later.

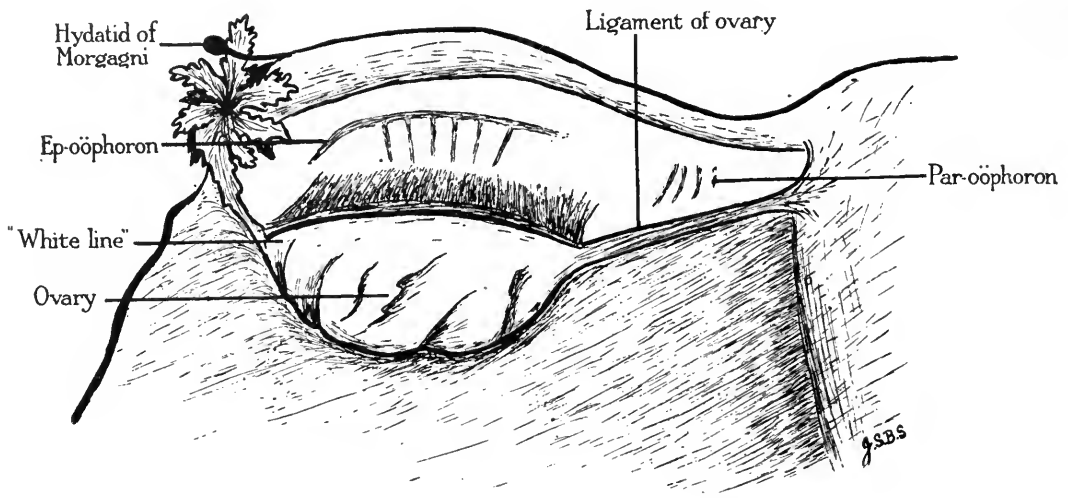


FIG. 23.—The posterior aspect of the left broad ligament.

(v.) *Lymphatics and Connective Tissue.*—Practically all the connective tissue is

to be found in the mesometrium, and it gradually increases in amount as the pelvic floor is approached (Fig. 22).

(vi.) *Vestigial structures*.—(a) The *ep-oöphoron* lies in the lateral part of the mesosalpinx, and consists of the remains of the Wolffian duct as it runs parallel to

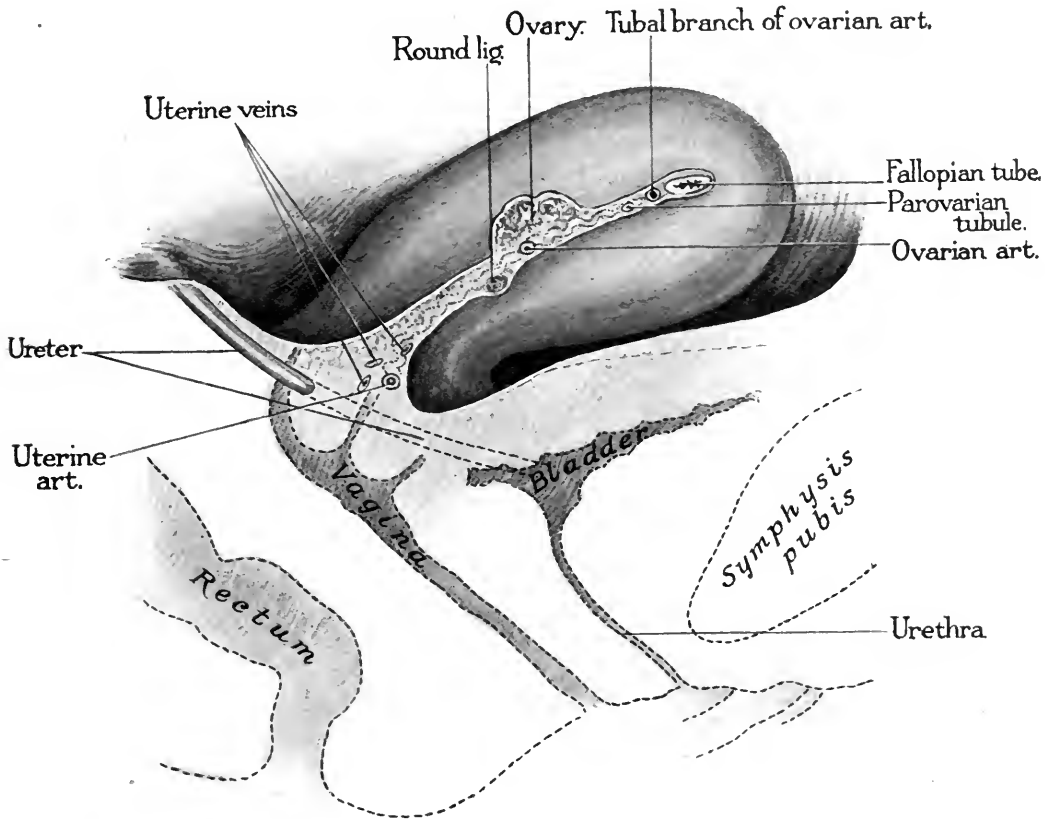


FIG. 24.—Section through the broad ligament outside the uterine border (diagrammatic). (Eden.)

the Fallopian tube, and a number of mesonephric tubules which open at right angles into this. (b) *Par-oöphoron*. When present the par-oöphoron is composed of a few tubules in the medial part of the mesosalpinx and represents the more caudal mesonephric tubules. (c) *Gartner's duct*, the caudal extremity of the Wolffian duct, may occasionally persist, but is more often imbedded in the tissues of the uterus and vagina, or in the mesometrium running parallel to the uterus. (d) Mesonephric tubules frequently persist in the mesovarium.

V. THE ANATOMY OF THE CONNECTIVE TISSUE, BLOOD-VESSELS, NERVES, AND LYMPHATICS OF THE FEMALE PELVIS

Superiorly the *connective tissue* of the female pelvis is continuous on all sides with the retroperitoneal connective tissue of the abdomen ; but in the pelvis it is more abundant and of infinitely greater importance, for it packs all the interstices between the organs and acts as a medium in which ramify the pelvic blood-vessels, nerves, and lymphatics. It increases in amount from above downward, and is especially plentiful between the peritoneum and the muscles of the pelvic diaphragm. The proportion of connective tissue to the contained vessels and nerves also varies

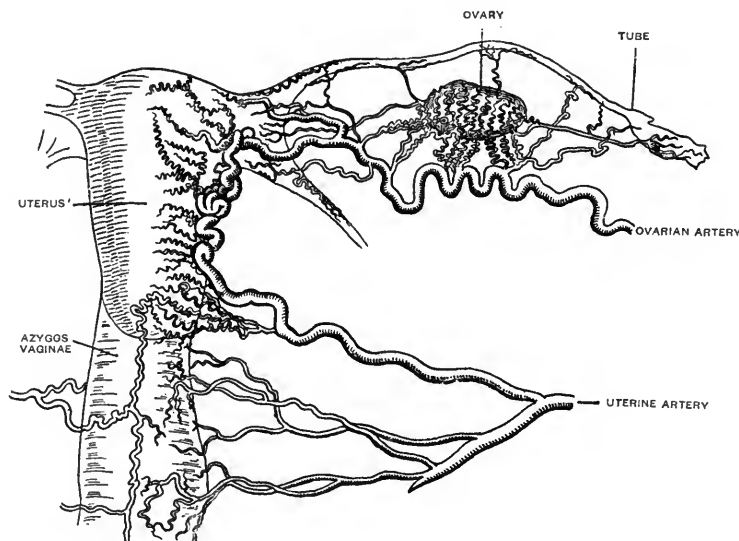


FIG. 25.—Blood-supply of uterus. (Hyrthl, 1873.)

in the several parts of the pelvis. Around the cervix uteri, where it forms the parametric tissue of Virchow, it is most abundant and very vascular (see especially Figs. 30 and 32). In the section devoted to the anatomy of the viscera reference has been made to portions of the connective tissue between the cervix and the posterior wall of the bladder, and between the vagina and the anterior wall of the rectum. Hence this tissue both fills up the spaces between the several viscera in the middle line, and occupies the area between the viscera and the two pubo-coccygei muscles, in which latter situation it transmits the blood-vessels running between the internal iliac vessels and the viscera.

The precise attachments and more exact relations of the pelvic connective tissue will be described in the section on the supports of the uterus (p. 35).

Arteries.—The *ovarian artery*, which arises directly from the aorta, crosses the pelvic brim and reaches the mesosalpinx by passing between the two layers of the

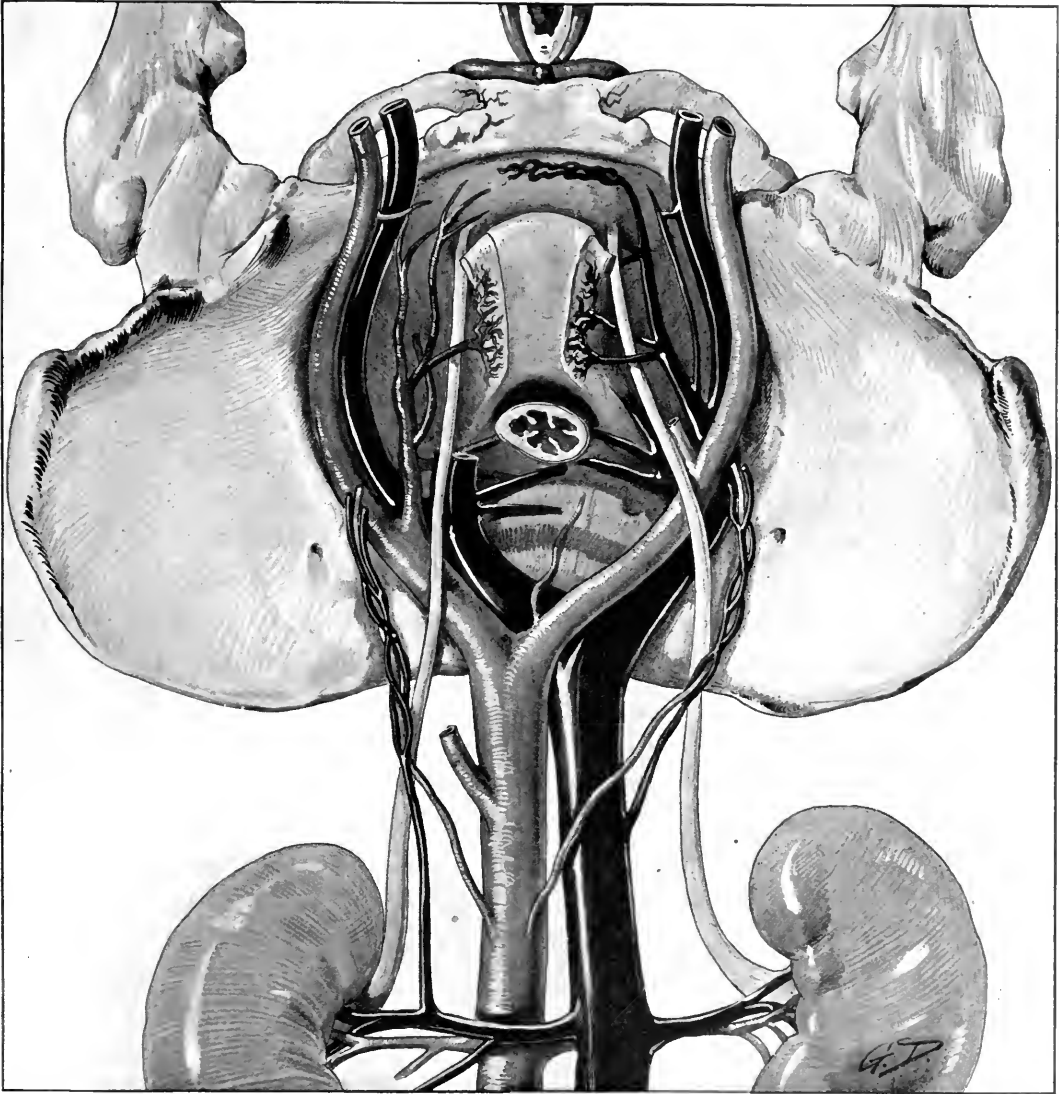


FIG. 26.—Dissection to illustrate the whole course of the ureters and the relations of the uterine artery (left side of subject) and veins (right) to the ureters. (After Liepmann.¹)

infundibulo - pelvic fold. It extends medially in the mesosalpinx, parallel to the Fallopian tube, and divides into branches which enter the mesovarium to supply

¹ Liepmann, *Atlas der Operations-Anatomie und Operations-Pathologie der weiblichen Sexualorgane*, 1912.

the ovary. It also transmits branches to the Fallopian tube, and the round ligament, and one to anastomose with the uterine artery.

The *uterine artery*, a branch of the anterior division of the internal iliac, runs forward to the lower border of the broad ligament, after reaching which it passes medially toward the cervix and crosses the ureter at the level of the external os (Fig. 24). On reaching the lateral fornix it turns upward in the mesometrium, parallel to the lateral border of the uterus, and supplies branches to the upper part of the vagina, the uterus, and the medial portion of the Fallopian tube; and finally it terminates in the region of the lateral angle of the uterus by anastomosing with a branch of the ovarian artery (Fig. 25). The uterine branches of the two sides freely communicate with each other.

The *vaginal artery* is usually a branch of the anterior division of the internal iliac. It passes to the lateral wall of the vagina, on reaching which it breaks up into branches for the supply of the vagina and also the bulb and neck of the bladder.

By anastomosing with the uterine artery it frequently forms two or more longitudinal vessels known as the vaginal azygos arteries.

Veins.—The veins which drain the pelvic viscera form networks, which freely communicate in the pelvic connective tissue. Hence there are vesical, utero-vaginal, ovarian (or pampiniform), and haemorrhoidal plexuses, which are linked together by anastomosing channels, and which also communicate with the parietal veins and those of the external genitalia.

The efferent vessels which drain these plexuses open, with two exceptions, into the internal iliac vein. The superior haemorrhoidal channels pass to the inferior mesenteric vein and thus to the portal system; the right ovarian vein is a tributary of the inferior vena cava whereas the left runs into the left renal vein (Fig. 26).

The wide and free communication between all the veins of the pelvis is an important factor in the rapid progress of certain septic conditions.

Nerves.—The nerves of the pelvis are spinal and sympathetic. The levator ani is innervated by the inferior haemorrhoidal branch of the internal pudic, and by the fourth and fifth sacral and coccygeal nerves; the coccygeal nerves and the fourth and fifth sacral also supply the coccygeus. Branches of the internal pudic nerve pass to the muscles of the perineum and clitoris.

The sympathetic branches are arranged in many plexuses. The hypogastric plexus is situated between the common iliac arteries and gives branches which, with those from the lumbar and sacral ganglia and sacral nerves, make up the inferior hypogastric plexuses lying on each side of the vagina. Branches from them pass to the vagina, uterus, Fallopian tubes, and ovaries. Special end-bulbs are found in the clitoris

and labia minora. In the vagina the nerves end in the epithelium. In the uterus, nerve plexuses and nerve cells are present in the muscular coat, and the nerve-endings can be traced to the glands and epithelium.

Pain is a common gynaecological symptom, and to facilitate the diagnosis it may be useful to locate, clearly and accurately, the exact site to which pain is referred, as well as its character and type. In a paper in *Brain*, Head¹ has attempted to give greater accuracy to the definition of these painful areas. He states that the area for ovarian pain is "limited above by a line running horizontally from the top of the first lumbar spine to the umbilicus, below by a line running from the third lumbar spine to midway between the pubes and the umbilicus but having a little downward tag near the anterior superior iliac spine." For the

body of the uterus and Fallopian tubes the area is bounded above by the preceding one, and below by a line running from a little below the top of the sacrum to the symphysis but having a dip down over the buttock and another over the front of the thigh. For the cervix uteri the painful area is

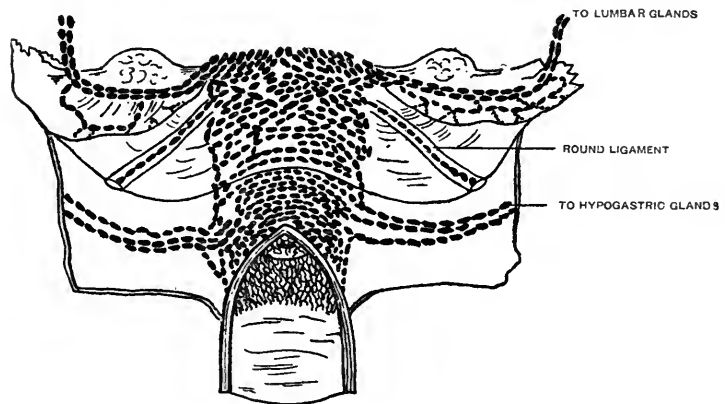


FIG. 27.—Lymphatics of uterus. (Poirier and Cunéo.)

over the lower part of the sacrum. For the ovary, therefore, it is formed by the sensory fibres from the tenth dorsal nerve root; for the body of the uterus and Fallopian tubes by the sensory fibres of the eleventh and twelfth dorsal nerve roots; and for the cervix by the sensory fibres of the third and fourth sacral nerves.

Lymphatics.²—The lymphatic vessels of the pelvis begin in connective tissue spaces, and, after forming plexuses, are so arranged that those from definite areas drain into definite groups of glands. Thus the lymphatics of the external genitalia and lower fourth of the vagina pour into the oblique inguinal glands; those of the upper three-fourths of the vagina and the whole of the cervix uteri into the glands lying in contact with the common, internal, and external iliac vessels.

The lymphatic vessels of the body of the uterus pass laterally in the broad

¹ Henry Head, *Brain*, 1893, vol. xvi. pp. 105-108.

² Poirier and Cunéo, *Les Lymphatiques* (1909), pp. 1191-1201, in Poirier and Charpy's *Traité d'anatomie humaine*, Paris, i., ii., 4^{ième} fasc.

ligaments, and, accompanied by those from the ovary and Fallopian tube, reach the lumbar glands (Figs. 27 and 28). A few lymphatics from the uterus run along the round ligament to open into the inguinal glands, and a gland lying on the obturator membrane also establishes a communication between the pelvic connective tissue and the inguinal glands. The lymphatics of the anus drain into the oblique inguinal glands, those of the anal canal into the internal iliac glands, and those from the rectum into the sacral glands from which efferent vessels accompany the superior haemor-

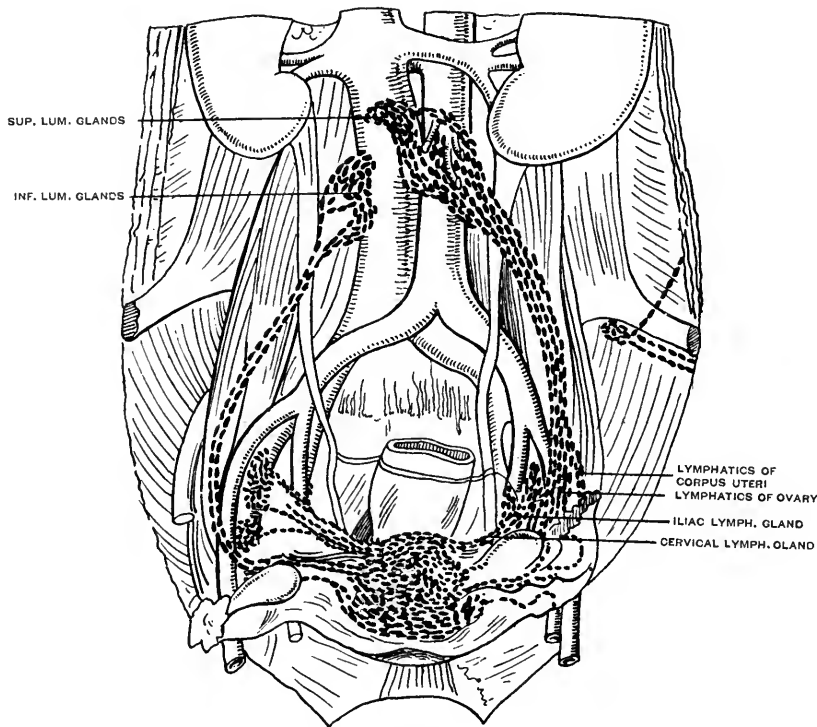


FIG. 28.—Lymphatics of uterus and pelvis. (Poirier and Cunéo.)

rhoidal and inferior mesenteric vessels to the preaortic glands lying around the upper ends of the latter vessels. The lymphatics of the bladder pass to the iliac glands.

These facts are of great pathological importance. In malignant disease of the external genital organs and lower fourth of the vagina, the oblique inguinal glands are affected; but in cancer higher up, the pelvic and lumbar glands are first infiltrated. Late infection of the inguinal glands may occur rarely in cases of uterine cancer, through the lymphatics found in the round ligament and also by means of the obturator gland.

VI. THE SUPPORTS OF THE UTERUS¹

In studying the means by which the normal uterus is supported and retained in its position, chief attention should be given to the connective tissues surrounding the upper part of the vagina (the part that lies above the level of the lower border of the pubo-coccygeus) and the cervix uteri (Figs. 29, 30, and 32).

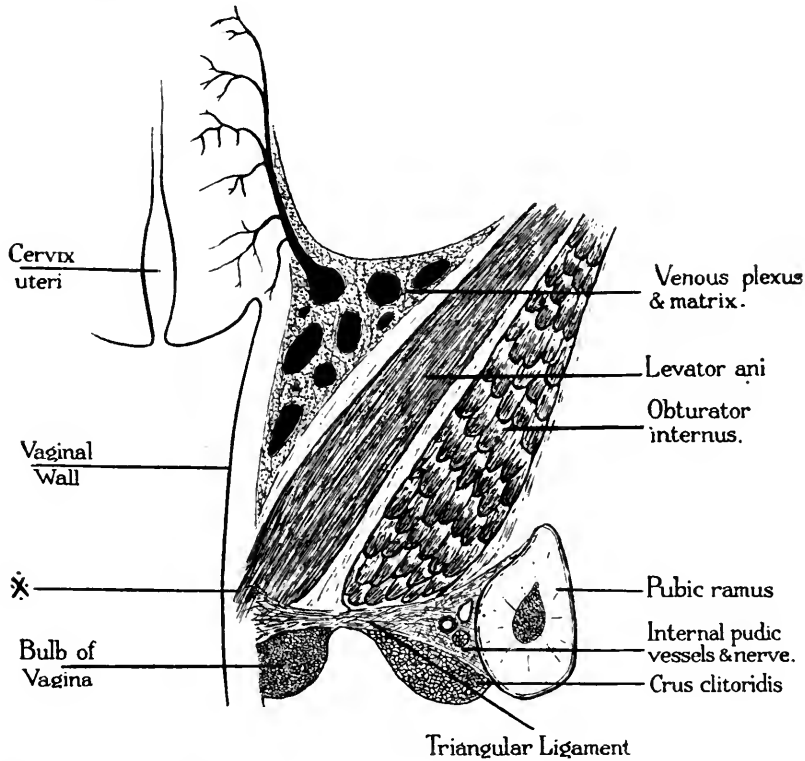


FIG. 29.—Diagram of a coronal section to indicate the relations of the fibrous matrix of the veins, and its attachment to the cervix uteri and upper part of the vagina. At * the levator ani (pubo-coccygeus), and triangular ligament are firmly attached to the vaginal wall.

As the sloping inner surface of the levator ani (pubo-coccygeus) muscle approaches the vagina, the deep cleft between the two structures harbours a great mass of blood-vessels passing to and from the anterior pelvic viscera and to some extent the pudendum (Figs. 29 and 30). The most obtrusive elements in this vascular mass are the vesical and utero-vaginal plexuses of large veins; but in addition there are vesical, vaginal, and uterine arteries, a multitude of nerves and lymphatics, and the ureter (Fig. 32). Each of these structures is invested by a covering of connective

¹ Derry, *op. cit. supra*, p. 97; Elliot Smith, *op. cit.* p. 198; Fothergill, *Journ. Obst. and Gynaec.*, January 1908; Cameron, *Journ. Anat. and Phys.*, 1908, p. 112. [This subject is also discussed in the Articles on Backward Displacement and Prolapse (see Vol. II. pp. 600 and 635).—EDITORS.]

tissue, and where a vast number of vessels become assembled within a restricted space the perivascular sheaths, joined one to another, form a considerable mass of strong tissue such as is shown in Fig. 32.

As the majority of these vessels are continued into the tissues of the uterus, (Fig. 31) vagina, bladder, or urethra, where each is widely ramified, it is obvious that

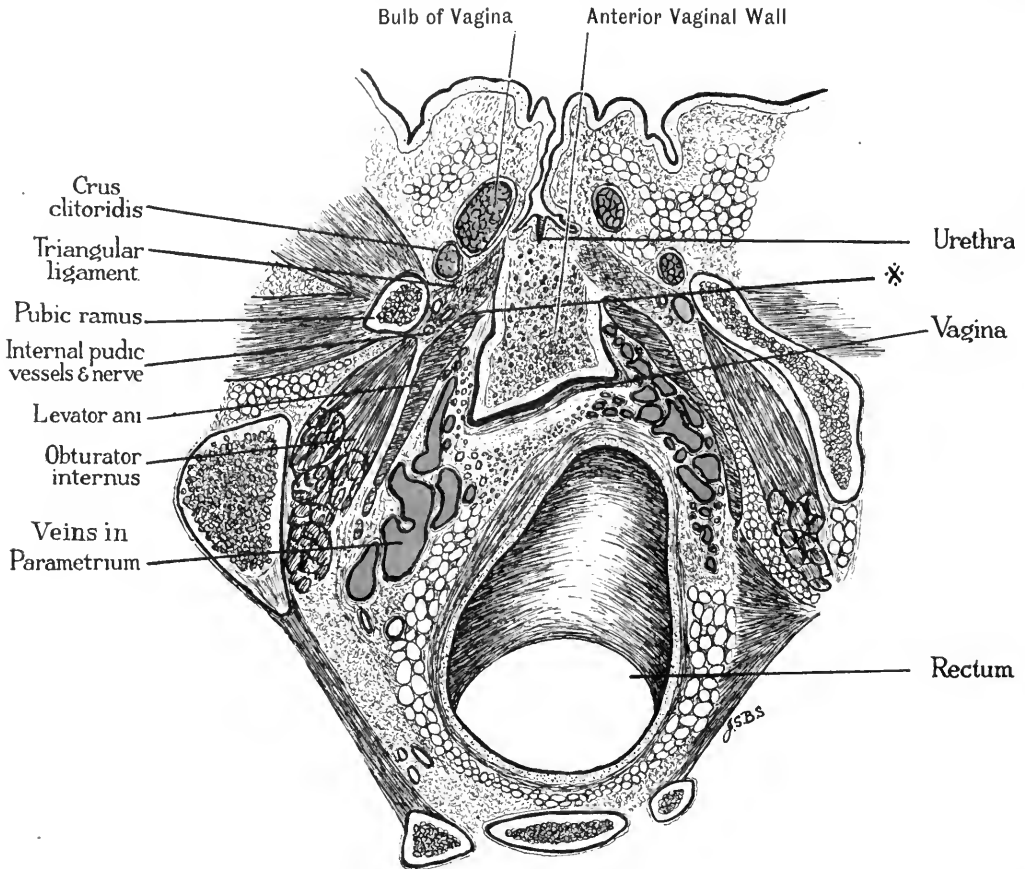


FIG. 30.—A transverse section of the female pelvis, cutting the vagina very obliquely (almost in its long axis). To show the great mass of perivascular tissue firmly fixed: I. To the upper vaginal wall; II. to the sheath of the levator ani; and III. to the triangular ligament. (For the facilities for making the sections represented in Figs. 30 and 32 I am indebted to Professor Beghet Bey Wahby of the Cairo School of Medicine.—G. E. S.)

the fibrous matrix formed of the perivascular sheaths is most intimately fixed to these viscera. Moreover, as the pudendal veins pass backwards from the region of the clitoris, some of them establish communications with the vesical plexus, others with the internal pudic and other parietal veins (Fig. 31). Thus the matrix formed by the vascular sheaths becomes firmly attached anteriorly to the pelvic wall as well as to the pubic region of the perineum.

The vessels which we have been considering carry blood mainly to or from the internal iliac vein or artery respectively: hence it is clear that the perivascular sheaths become firmly implanted posteriorly by joining the mass of tissue, which invests the internal iliac vein and artery. Indirectly they also become continuous with that belonging to all its parietal branches, gluteal, sciatic, internal pudic, and the rest, as well as the external and common iliac vessels; thus are formed so many outspread roots fixing the fibrous matrix posteriorly.

Thus each mass of perivascular tissue forms a firm sling-like band (collected around the vessels shown in Fig. 31) firmly fixed at its anterior and posterior extremities by its manifold roots, and equally intimately linked to the upper part of the vagina, the uterus, urethra, and bladder.

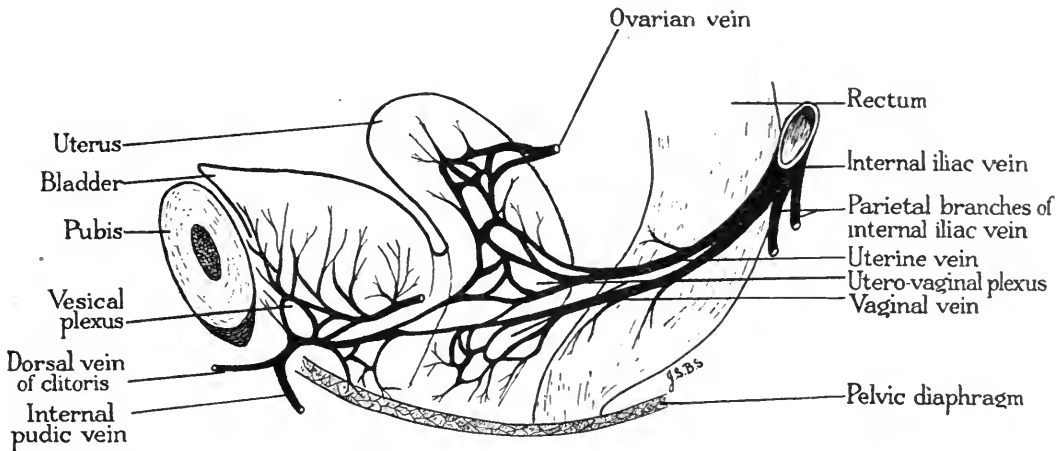


FIG. 31.—Diagram of the pelvic venous plexuses. To show the relations of veins to the bladder and vagina, and to illustrate their fixation in front and behind.

But this strong band of tissue is not simply an assemblage of vascular sheaths. There are added to it the tissues investing all the hundreds of nerves and lymphatics, the ureter and the viscera themselves; and the sheaths of all these structures are not merely added one to the other to form a considerable mass, but the fibrous element is strengthened so that a very solid mass of strong dense tissue is formed. To this, moreover, there is added a considerable quantity of unstripped muscle, which is distributed throughout the mass of the parametrium and in some places formed into definite bands which some writers describe as *ligaments*.

It cannot be too strongly emphasized, however, that the essential support of the uterus is provided by the parametrium as a whole (Fig. 32), and not by any of its constituent elements that may be isolated by more or less arbitrary and misleading dissections. Where the levator ani and its sheath are fixed to the triangular

ligament and the vagina, the perivascular matrix also becomes firmly united to these structures (Figs. 29 and 30). But this attachment of the matrix to the levator ani or

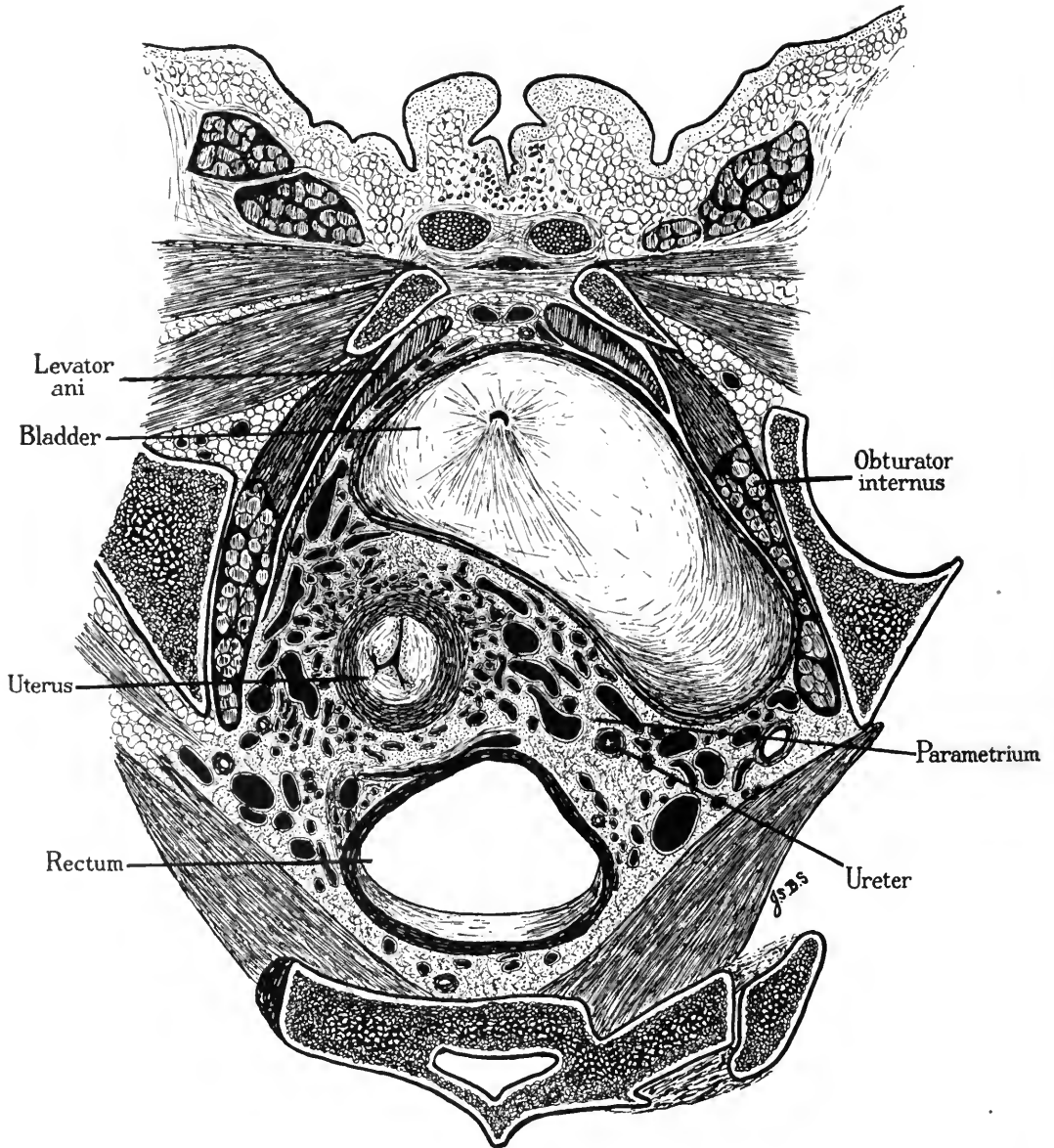


FIG. 32.—Transverse section through the pelvis at the level of the cervix uteri to illustrate the nature and relations of the parametrium. The uterus is displaced to the left and the bladder fills up the space on the right.

its sheath is not essential to the supporting function of the parametrium, although no doubt it contributes to it in some small measure.

PHYSIOLOGY OF THE FEMALE REPRODUCTIVE ORGANS

By LOUISE M'ILROY, M.D.
(Glasgow)

SYNOPSIS

- I. (a) Structure and Functions of External Genitals, Vagina, Cervix, and Uterus. (b) Structure of Uterine Mucosa during Phases of Menstrual Cycle. (c) Structure of Fallopian Tube.
- II. (a) Development of the Ovary. Oögenesis. (b) Structure of Graafian Follicle and Corpus Luteum.
- III. (a) Theories of Menstruation. (b) Changes which occur at Puberty. (c) The Menstrual Cycle. (d) Functions of Corpus Luteum and Interstitial Cells, and Factors which influence Menstruation.
- IV. (a) Menstruation and Ovulation. (b) Factors which influence Fertilization.
- V. (a) Influence of Ovarian Secretion upon Development, Growth, Pregnancy, and Metabolism. (b) Transplantation of Ovaries. (c) Secondary Sex-Characteristics. (d) The Menopause.
- VI. Function of the Uterine Mucosa.
- VII. Structure of the Mammas. Mammary Secretion.
- VIII. Correlation of the Internal Secretory Organs with the Function of Reproduction.

SECTION I

A. STRUCTURE AND FUNCTIONS OF EXTERNAL GENITALS, VAGINA, CERVIX, AND UTERUS¹

External Genitals.—The *mons veneris* is composed mainly of fatty tissue, vascular, and nerve structures. In the adult it is covered with hair. It serves as a protection from pressure upon the sensitive structures in the region of the clitoris. The *labia majora* are covered with skin and hair in the adult condition. The inner

¹ The gross anatomy and topography of these parts has been described in the preceding Article on Anatomy.—EDITORS.

surface is moist and richly supplied with sebaceous glands. There is a dense layer of subcuticular stroma containing elastic fibres. The greater portion is composed of loose areolar tissue; no muscular tissue has been observed. There is a rich supply of veins. In the virgin the labia majora are closely applied to one another. They are separated in multiparae, and are less prominent. After the menopause atrophy takes place. The *labia minora* are thin folds covered with stratified epithelium, and composed of loose connective tissue, blood-vessels, and numerous nerve-endings. There is a considerable amount of erectile tissue in their substance. They contain sebaceous follicles and a few sweat glands. In the virgin the labia minora are hidden, but they project in women who have borne children. Non-striated muscular fibres are seen in these tissues. The chief function of the labia is to assist in coitus by the lubricating action of their glands. They are homologous with skin structures. Hypertrophy sometimes is marked. The *clitoris* is composed of erectile tissue in its body; the glans is covered with squamous epithelium, rich in nerve-endings and vessels, and is very sensitive. It is the chief centre for stimulation in sexual intercourse. It is sometimes found to be enlarged in different individuals and races. The *vestibular bulbs* are composed of erectile tissue, stroma, and cavernous blood spaces. *Bartholin's glands* are compound racemose glands, lined with cubical epithelium. They contain a viscid clear or yellow fluid which they secrete during sexual excitement. Numerous small mucous glands open upon the upper part of the vestibule, and some of these with dilated orifices have the appearance of lacunae. Skene's ducts, which belong to the same class, open on to the surface at either side of the floor of the urethra. The *hymen* is composed of connective tissue with elastic fibres, covered with stratified epithelium on both surfaces. It sometimes contains papillae, nerve-endings, and blood-vessels. In the early embryo it is a solid mass of epithelial cells, which at a later stage becomes canalized, like the vagina itself. The hymen as a rule tears at the first coitus, and sometimes haemorrhage is severe. Rigidity of the hymen may cause sterility, and imperforation may lead to retention of the menstrual discharge. Imperforation is due to failure of degeneration in the central epithelial cells, by means of which a lumen is formed under normal conditions.

Vagina.—The vagina is formed by a fusion of the terminal ends of the Müllerian ducts. It is composed of three layers—mucous, muscular, and connective tissue. The *mucous layer* is composed of many layers of pavement epithelium. The lower layers show the presence of columnar epithelium, the flattened cells being observed nearer the surface. The submucous layer is composed of connective tissue with blood-vessels. It projects into the mucous layer and forms papillae, with lymphoid

nodules through its substance. According to most authors the vagina does not contain glands (Gebhard,¹ Waldeyer,² W. Williams³). The statement that glands are present may have been made as a result of observations upon inclusions of the mucous membrane, with retention of secretion.

The *muscular* layer of the vagina consists of a circular or inner layer and an outer longitudinal layer of non-striated muscular fibres. There is a considerable amount of connective tissue, rich in blood-vessels, and elastic tissue.

The moist condition of the vagina is due to the secretion from the uterine glands, and also to the secretion of the vaginal epithelium. This secretion is acid in reaction, which is said to be due to the normal presence of lactic acid (Döderlein). The vaginal epithelium is many-layered pavement in type, that of the cervix is non-stratified and cylindrical. The boundary line between them according to Keibel and Mall lies at first in the cervical canal. The cervical epithelium destroys the pavement epithelium as far as the external os uteri; sometimes a congenital histological ectropion is formed. The cervical epithelium is compressed by the pavement epithelium, and there is a mutual struggle between the vaginal and cervical epithelium at the level of the external os. If the cervix be small and the external os and cervical canal are narrow, the boundary lies above the os. If the cervix be large and the os broad, the boundary lies below the os on the vaginal surface of the *portio vaginalis*. The boundary line is irregular, and islands of cervical epithelium are included on the vaginal surface of the portio. This is known as "physiological erosion."

Cervix.—The mucous membrane of the *cervix* is composed of folded mucosa, the remains of the wavy folds of the embryonic uterus which disappear with development. One of

these folds, which may persist to a certain extent, and distinguish the cavity of the body from that of the cervix like a valve, is frequently the cause of obstruction in the discharge of menstrual fluid in adult life, and also of sterility. The wall of the

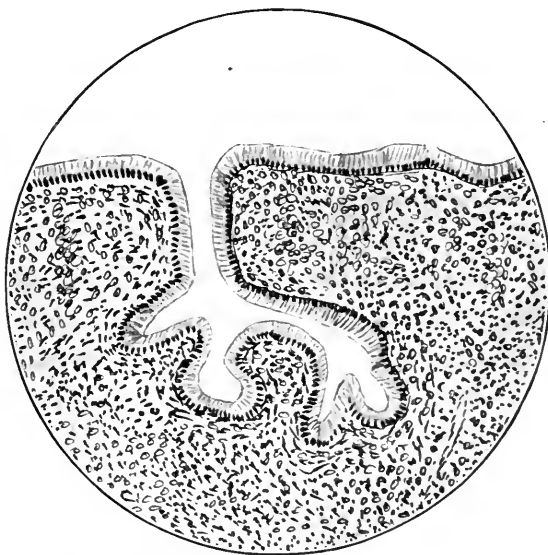


FIG. 33.—Wall of cervix showing a racemose gland.

¹ Gebhard, *Zeit. f. Geb. u. Gyn.* Bd. xxxii.

² Waldeyer, *Eierstöcke u. Ei*, 1870.

³ Whitridge Williams, *Obstetrics*, 1912.

cervix is composed of non-striated muscular fibres with elastic tissue. The wavy folds of the cervical and uterine mucosa are known as the *arbor vitae uterine*. They persist in the cervix until after childbirth, as a rule. The mucosa of the cervix is composed of a single layer of columnar epithelium, resting on a thin basement membrane. The nuclei are basal in position, and the cells are ciliated. The cervical glands are branched (Fig. 33), and extend from the muscular coat to the surface. They are lined with epithelium like that of the surface, and secrete a thick, transparent, alkaline mucus. The opening of the glands frequently becomes occluded; distension then occurs, and they project as nodules on the surface, the *Ovula Nabothii*.

Uterus.—The uterine wall is composed of three layers of tissue—serous, muscular, and mucosal. The *serous* layer is formed by the peritoneum which covers it throughout. The *muscular* wall is composed of a very great number of bundles of non-striated muscular fibres. There is a considerable amount of fibrous stroma-tissue and elastic fibres. It is difficult to differentiate between the bundle-fibres in the uterus, as they are closely matted together, so as to form a felt-like structure. The fibres run in all directions in the substance of the walls. There are numerous blood-vessels and nerves. The muscular wall of the uterus becomes more complicated in arrangement as puberty is approached. The structure of the uterine *mucosa* is so complicated that a separate sub-section will be assigned to its consideration.

B. STRUCTURE OF THE UTERINE MUCOSA DURING THE PHASES OF THE MENSTRUAL CYCLE

In infancy the uterine mucosa consists mainly of stroma-tissue, blood-vessels, and surface-epithelium. Glands are present but are few in number, and in some specimens they appear as mere depressions on the surface.

At puberty various alterations take place in the histological structure of the uterine mucosa, and these changes occur with cyclic recurrence during the whole reproductive life of the individual. They consist mainly of an alternate building up and breaking down of the superficial layers of the mucosa; the whole process being known as a *complete menstrual cycle*. It is therefore necessary in any description of the uterine mucosa to include all the different phases which take place. Menstrual alterations differ widely from the resting condition as seen in the intermenstrual period; so much so indeed, that in the histological examination of the mucosa, the exact date of the menstrual cycle should be noted in order that what is a normal physiological condition should not be mistaken for a pathological one. This is a common source of error in the examination of scrapings from the interior of the

uterus, seeing that in many cases they are diagnosed as inflammatory when they are merely the changes which are normal in the premenstrual or menstrual phases.

For a more detailed study of the changes which take place in the uterine mucosa, the work of Webster,¹ Heape,² Young,³ Hitschmann and Adler⁴ should be consulted.

The complete menstrual cycle in a normal individual averages about twenty-eight days in duration, and for descriptive purposes it is divided into four phases. It must be remembered, however, that no hard-and-fast line can be drawn between these phases, the one gradually merging into the other so that it is difficult to define with certainty where one begins and the other ends.

Phases of the Menstrual Cycle.—(1) *The Intermenstrual or Resting Phase; Anoestrus*—average duration, 12 days.

(2) *The Premenstrual Phase*, or period of growth; *Prooestrus*—duration, 5 days.

(3) *The Menstrual Phase*, or period of degeneration; *Prooestrus*—duration, 4 days.

(4) *The Postmenstrual Phase*, or period of recuperation; *Oestrus*—duration, 7 days.

1. *The Intermenstrual Phase* may be taken as the normal condition of the resting mucosa. It corresponds to the *anoestrus*, or period in animals when breeding does not take place. During this phase the uterine mucosa is about 2 to 3 mm. in thickness. It is greyish-pink in colour, of semi-fluid consistence, and its surface is wavy in outline. The line of demarcation between the mucosa and the muscular layer is not well seen, as portions of the mucosa project into the muscularis forming a close attachment to the latter. It has been suggested that after the removal of the mucosa regeneration takes place from the underlying muscularis (W. Williams). The surface of the mucosa appears pitted with small openings—the mouths of the glands. On histological examination the mucosa is seen to be composed of a single layer of surface epithelium, as well as glands, stroma, and numerous blood-vessels.

The *surface epithelium* consists of a layer of columnar ciliated cells, the nuclei of which are oval in outline and basal in position (Fig. 35). The glands are unbranched except in their deeper portions; they are wavy in outline, open obliquely on to the surface and extend down into the muscular layer. The epithelium lining the glands is continuous with that on the surface of the mucosa. The nuclei are somewhat larger than those of the surface epithelium, the cells being columnar in shape with cilia

¹ Webster, *Human Placentation*, 1900.

² Heape, *Phil. Trans. Roy. Soc.*, 1897; *Quart. Journ. of Microscop. Soc.*, 1900; *Proc. Roy. Soc.*, 1905.

³ Young, *Reproduction in the Human Female*, 1911.

⁴ Hitschmann and Adler, *Zeit. f. Geb. und Gyn.*, 1907.

on the free surface. During this phase the glands contain very little mucous secretion. The main portion of the mucosa is composed of stroma-tissue, the cells of which vary greatly in size and outline, being round-, spindle-, or star-shaped. The intercellular spaces are larger in the deeper layers, but the cells are closely packed in the superficial portion. The cell-membrane is not well defined, the protoplasm being drawn out into fine processes or filaments which anastomose with one another,

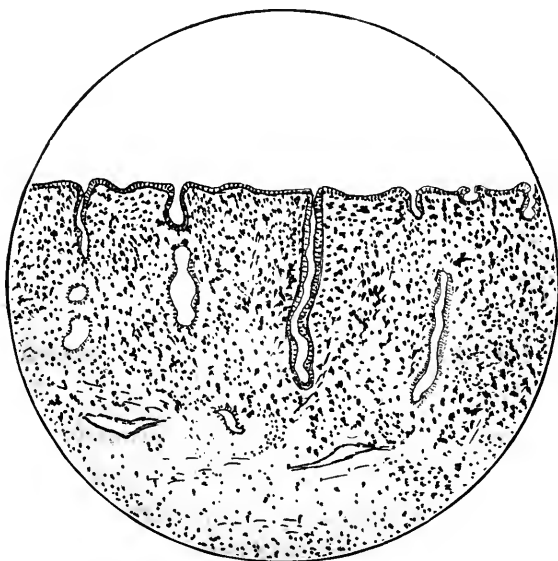


FIG. 34.—Section of uterine mucosa, showing epithelium, glands, and stroma. (Intermenstrual or resting phase.)

forming the boundaries of the intercellular spaces. The nuclei of the stroma appear more dense in the neighbourhood of the epithelial cells, and lie in a direction parallel to the latter. In the vicinity of the blood-vessels the cells are more closely packed, and may form a limiting membrane for the newly formed blood-vessels. The blood-vessels, which are derived from the vessels in the deeper layer of muscle, are tortuous in their course and have numerous branches. Towards the surface and also in the neighbourhood of the glands the capillaries form a fine network under

the epithelium. The smaller capillaries do not appear to have a definite endothelial wall, but their boundaries are formed by modified stroma-cells.

According to Young the stroma-cells, although forming an interlacing network by means of their protoplasmic processes, remain completely separate from each other. These processes enclose definite intercellular spaces, which contain a clear and sometimes granular fluid resembling lymph.

The variation in the shape of the stroma-cells depends mainly upon the degree of pressure exerted upon them, and upon the functional changes which take place in the mucosa. There is a change not only in shape and outline, but in chemical composition, as proved by variations in capacity for taking up acid and alkaline stains. In the outer layers of the mucosa the stroma-cells are numerous and more closely packed together. In the deeper layers the intercellular spaces are large and the whole tissue is spongy in appearance. In the deeper layers the blood-vessels have a distinct cell wall, and strands of muscular and elastic fibres have been seen in their

vicinity. Such fibres are not found in the superficial layers. In the resting stage red blood-corpuscles are sometimes seen in the intercellular spaces.

The uterine mucosa somewhat resembles embryonic tissue, and in its construction suggests the idea of adaptation to the changes in function which occur during the menstrual cycle. Some authors believe with Leopold¹ that the mucosa is of the nature of a lymphoid sponge. Although there is no definite proof for the assertion, it may be supposed that histological changes in the mucosa are the result of marked chemical alterations in the composition of the protoplasm of the cells. Chemical substances reach the mucosa by means of the blood stream, and cause changes to take place in the composition of the mucosa-cells. The mucosa on its part may possibly generate substances which enter the general circulation, and bring about alterations in the organism as a whole.

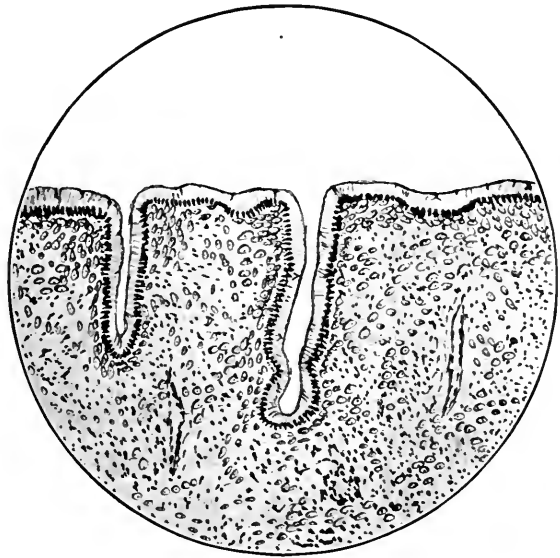


FIG. 35.—Surface-epithelium of uterine mucosa. (H.P.)

2. *The Premenstrual Phase* is characterized by swelling and proliferation of the mucosa, which increases to about 6 or 7 mm. in thickness, the cavity of the uterus being almost obliterated. The phase occurs about eighteen days after the last menstrual period, and the extent of the changes which occur depends very much upon the physiology of the individual concerned. There is gradual transition into the menstrual phase, these two phases corresponding to the *prooestrus* in animals, that is the period preceding fertilization. The increase in thickness of the mucosa is due mainly to oedema, *i.e.* an increase in the amount of fluid in the intercellular spaces, and also to an enlargement of the epithelial cells, glands, and blood-vessels. A certain amount of cell-multiplication also takes place, being more marked in the superficial layers. The mucosa becomes folded in outline. The glands are distended with mucus, and hæmorrhagic extravasations are to be seen in the stroma.

The glands are elongated, their lumina being also increased by distension from mucous secretion. The epithelial cells are enlarged and more discrete, the

¹ Leopold, *Arch. f. Gyn.*, 1883.

nuclei being rounded and concentrically situated. There is an increased amount of mucus in the uterine cavity. The intercellular spaces are distended with fluid, the protoplasm of the cells being drawn out so as to enclose large areas. In places, detachment of the cellular processes is observed, by means of which lacunae are produced (Fig. 36), and the mucosa takes on the appearance of a spongy mass in its deeper layers. The nuclei are enlarged and more rounded in outline. In the superficial layers of the mucosa, blood-corpuscles occur in the spaces both singly and in masses. In the neighbourhood of these masses of red blood-corpuscles, the epithelium in places may be raised up in the form of a blister—the *sub-epithelial haematomata* of Gebhard. Such

appearances, however, are more marked in the menstrual phase.

Newly formed capillaries are found in the superficial layers; in the deeper portions the vessels are increased in size. In the latter part of the premenstrual phase the whole mucosa has the character of a blood-sponge. It is generally accepted that in the early stages the tissues become infiltrated with fluid and a few red corpuscles, and that later there is a large increase in the number of red corpuscles. Much controversy exists as to the actual mode of escape of blood from the



FIG. 36.—Uterine mucosa in the premenstrual phase.

vessels. The view generally held is that in the early stages of haemorrhagic infiltration, the blood-corpuscles enter the intercellular spaces by the process of diapedesis, and that in the later stages the blood escapes from the vessels through actual openings in the vessel-walls caused by increased pressure from within. According to the recent researches of Young the stroma-tissue becomes infiltrated with fluid from the blood-stream by means of the power of imbibition of the stroma-cells themselves. These cells under certain chemical influences show a marked affinity for water. After exudation of fluid from the vessels, diapedesis of the corpuscles takes place in the early stages. By the passage of the corpuscles through the walls of the vessels, the endothelial cells become detached, and openings are formed through which great numbers of corpuscles pour into the surrounding stroma which has been previously disintegrated by fluid. The corpuscles stray in all directions and form haemorrhagic

areas in the substance of the stroma. In the small capillaries the mural cells are easily separated by the fluid exudate, although it is generally supposed that the lining cells take up fluid and pass it on in turn to others in their vicinity. The exudate of fluid is not due to *vis a tergo* in the vessels but to some chemical alteration in the stroma-cells causing the latter to take up fluid in greater quantities. Haemorrhagic infiltration is most marked in the superficial layers of the mucosa and in the neighbourhood of the glands. During the premenstrual phase the glands are enlarged and distended, and apparently increased in number, a fact which is merely due to the compression of the interglandular tissue. In the more superficial layers of the mucosa the stroma-cells are enlarged and rounded, and contain a large feebly staining nucleus. They closely resemble decidual cells (Fig. 37), and are said to be the preliminary stage of the latter (Hitschmann and Adler). The glandular enlargement in the deeper layers gives a spongy appearance, so that we recognize two layers in the mucosa corresponding to the compact and spongy layers of the uterine decidua.

The similarity of the premenstrual mucosa to that of the decidua points to the possibility that these changes are in the nature of a ripening process for the reception of the fertilized ovum, and therefore that this phase is physiologically the most important part of the cycle (Keibel and Mall).

3. *Menstrual Phase, or Period of Degeneration.*—This phase is characterized by the appearance of a haemorrhagic discharge from the uterus. The mucosa decreases in thickness, and degenerative changes occur. It is difficult to differentiate between the premenstrual and menstrual phases, for they might properly be considered as one process, the haemorrhage being the culminating part of a series of changes. During the menstrual phase the mucosa begins to shrink in amount. Some degeneration of superficial tissue takes place; amyloid or hyaline changes occur in the walls of the vessels which therefore break down. Blood is poured into the lacunae, bursts through the degenerated epithelium on the surface and into the

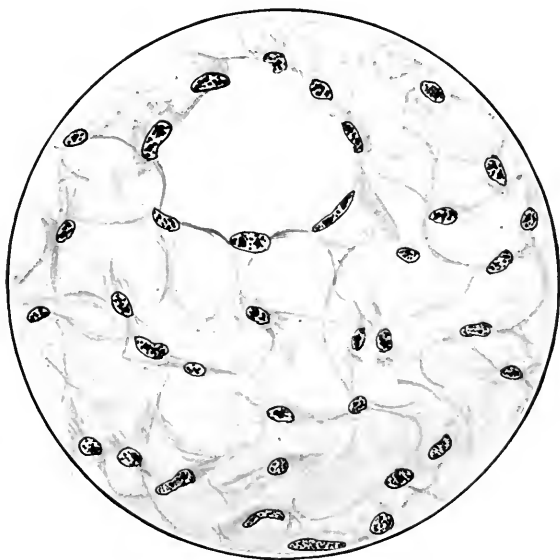


FIG. 37.—Uterine mucosa at first day of menstruation, showing the stroma-cell processes. (H.P.)

glands, and thus reaches the uterine cavity (Heape). The degenerated epithelium, detached stroma-cells, and blood-corpuscles form the so-called *menstrual clot*. It is supposed that the epithelium in places becomes lifted up and detached by the pressure of underlying haemorrhage, thus permitting the free passage of blood into the uterine cavity. The extent of the destruction in the superficial layers varies in different individuals and at different periods. Most investigators believe that the amount of tissue lost is inconsiderable (Leopold, Gebhard, W. Williams, Young).



FIG. 38.—Uterine mucosa at third day of menstruation, showing superficial degenerative changes. (L.P.)

the stroma-cells and red blood-corpuscles. All the cells become diminished in size and the whole mucosa shrinks.

Glycogen is said to be found in large quantities in the premenstrual and menstrual phases and to disappear immediately afterwards. This is looked upon as a provision for the nutrition of the early ovum (Wegelin).

The menstrual fluid varies in amount in different individuals, the average being between 2 and 6 oz. It is greater in women living in warm climates. During the early stages of the flow there is a considerable quantity of mucus in the discharge, followed by an increased amount of blood, which changes to mucus as the flow gradually ceases. There is an increased number of leucocytes in the early discharge. Under normal conditions, coagulation of the menstrual fluid does not take place, and hitherto this has been supposed to be due to the presence of mucus in its contents. Later researches, however, show that the non-coagulability is due to some other

Examination of normal menstrual fluid shows the presence of epithelial and stroma cells and red corpuscles, although rarely any organized mass of cells. In some individuals destruction of tissue is more marked at alternate phases of the menstrual cycle. There is little support for the theory that fatty degeneration of the vessel walls is a source of their destruction and the subsequent escape of blood, although this condition may be found under pathological circumstances. It may be looked upon as the result rather than the cause. Towards the end of the menstrual phase regeneration begins, the leucocytes absorb

substance, the exact nature of which is not known. That menstrual blood contains an increased amount of calcium as compared with systemic blood has been shown by Blair Bell,¹ and it is supposed that the calcium has some influence in preventing the occurrence of coagulation. The present author, however, believes that the non-coagulability is due to some substance in the nature of a ferment which is generated by the uterine mucosa or the ovary, but the composition of this substance is still unknown.

4. *Postmenstrual Phase*.—The process of repair begins before the cessation of the haemorrhage. It corresponds to the period of regeneration or involution (Gebhard). The epithelium, if separated, becomes replaced by multiplication of neighbouring cells. Mitosis has been observed by some authors in the stroma-cells. The blood-corpuscles gradually become drawn into the blood-stream by the formation of fine capillaries around them, the flattened stroma-cells forming the walls of these vessels, which become linked up with the larger capillaries and vessels. During the postmenstrual phase, the mucosa increases in thickness by new cell-formation, replacing the loss of tissue during the haemorrhagic phase. The blood-vessels and glands gradually decrease in size, and the mucosa takes on the appearance described under the resting or intermenstrual phase.

During the premenstrual and menstrual phases all the genital organs are oedematous and congested, and various changes take place in the organism as a whole which will be discussed later (p. 65).

C. THE FALLOPIAN TUBES

The Fallopian tubes are structurally similar to the uterus. They have a peritoneal covering, muscular layer, and mucosa. The walls of the tubes vary in thickness along their course. The muscle wall is composed of two layers—an inner circular and an outer longitudinal layer. Towards the uterine end the muscular fibres are



FIG. 39.—Uterine end of the Fallopian tube.
(Transverse section.)

¹ Blair Bell, "Arras and Gale Lectures," *British Medical Journal*, 1913; *Proc. Roy. Soc. of Med.*, 1913.

more dense than those at the outer portions. According to Whitridge Williams there is an inner layer of longitudinal fibres in the uterine portion of the tube. The tubal mucosa is very much convoluted, and is composed of a single layer of epithelial cells, columnar and ciliated, with an underlying stroma. The lumen of the tube

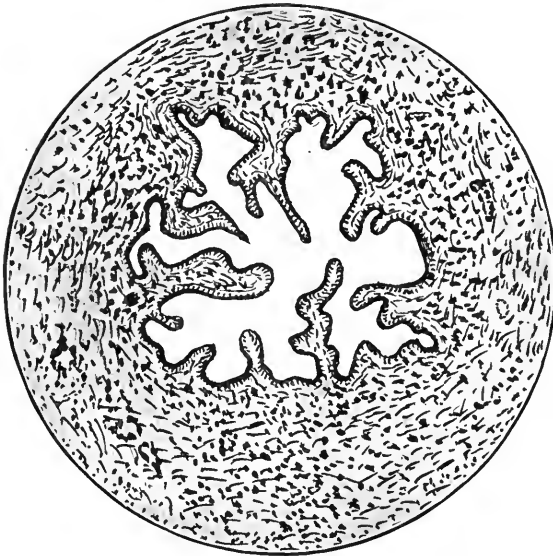


FIG. 40.—Ampullary end of Fallopian tube.
(Transverse section.)

varies throughout its course. At the uterine portion the mucosa is arranged in a few large convolutions. Towards the isthmic and ampullary portions the lumen is almost completely occluded by the *plicae* or folds of mucosa. There are no glands in the tubal mucosa, although inclusions of the surface epithelium are sometimes mistaken for these. The tubal mucosa participates to a slight extent in the changes which take place in the menstrual cycle, and oedema of the stroma with increase in the blood-supply is to be noted as in the uterine mucosa. In the adult the tubes are straighter

than in infancy, when there is considerable twisting, which, if persisting, may have some influence upon the questions of sterility and tubal pregnancy. The interior of the tube contains secretion which is a transudation from the epithelial cells, and acts as a medium for the transit of the ovum from the ovary to the uterus. Peristaltic movements take place in the walls, which, together with the ciliary action, serve to direct the contents of the tube in one or other of the paths open to them.

SECTION II

A. DEVELOPMENT OF THE OVARY. OÖGENESIS

The ovary has its origin in a group of specialized sex-cells lying on a ridge on the mesial aspect of each Wolffian body (Fig. 1). At an early stage of development it is impossible to differentiate between the embryonic ovary and testis, but at a later stage the characteristic formation of the ovary is observed. The primitive sex-cells

on the genital ridge increase in number by mitotic division up to a certain stage ; they then undergo a series of complicated changes according to the function to which they are destined. By the publication of Waldeyer's work,¹ the whole development of the ovary was put upon a clearer basis, and this has been amplified by subsequent observers. Among these are von Winiwarter² and Lane-Claypon.³

The genital ridge on the Wolffian body is made up of small undifferentiated cells, epithelial in character. These are the germ-cells which are laid down at the early segmentation of the ovum. The *medullary cords* are the first structures to appear in the deeper portions of the cell-mass ; these atrophy early and their function is unknown. It is supposed that they form ova which undergo early degeneration. All the cells in the primitive ovary are small, oval in outline, with granular nuclei and faintly staining nucleoli. These cells are known as *oögonia*, and it is from them that all the important structures of the ovary arise. The differentiation of the *capsular epithelium* takes place at a very early stage ; it is derived from the single superficial layer of *oögonia*. The cells increase in size and their axes come to lie at right angles to the underlying cells, thus forming a row of cubical epithelial cells upon the surface, the function of which is purely protective (Fig. 42). Invaginations of this epithelium are sometimes seen, and are formed by a heaping up of rows of cells which eventually become pushed down among the underlying stroma-cells. They form gland-like projections but without a central lumen. These cells take no part in the formation of ova or follicles.

During the process of development of the cells of the ovary there is an upgrowth of stroma cells from those beneath the genital ridge, together with a downgrowth of *oögonia*. The *oögonia* by means of the stroma-processes become divided up into columns and nests of cells. The stroma-cells eventually reach the periphery of the ovary and form a dense layer underneath the capsular epithelium—the *tunica albuginea* (Fig. 44). The function of the stroma is supporting and vascular. The masses of cells gradually form themselves into the characteristic shape of the ovary ; densely packed cells with deeply stained nuclei are found at the periphery or cortex and clear cells with dense stroma in the medullary portion (Fig. 41). The *cortex* of the embryonic ovary is therefore composed of numerous masses of *oögonia* with stroma-processes separating them. The *medulla* contains dense stroma-tissue with scattered *oögonia* in various stages of development, together with nerves,

¹ Waldeyer, *Eierstöcke und Ei*, 1870.

² Von Winiwarter, *Arch. de Biol.*, 1901.

³ Lane-Claypon, *Proc. Roy. Soc.*, 1906.

vessels, and the remains of the *rete tubules* which extend down to the hilum of the ovary.

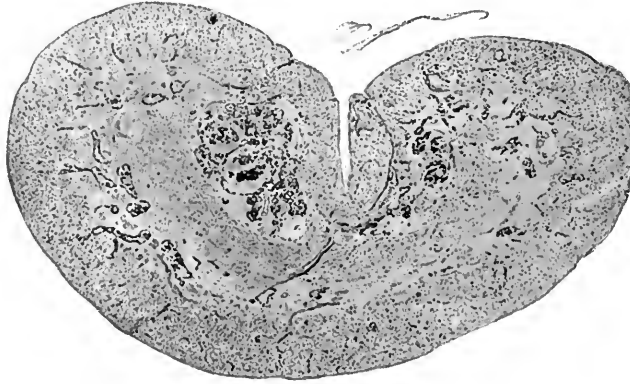


FIG. 41.—Pig embryo (12 cm.), showing cortical and medullary zones.

In some mammalian ovaries the oögonia are grouped by the stroma into columns of cells which have given rise to the supposition by Pflüger that the ovary contains

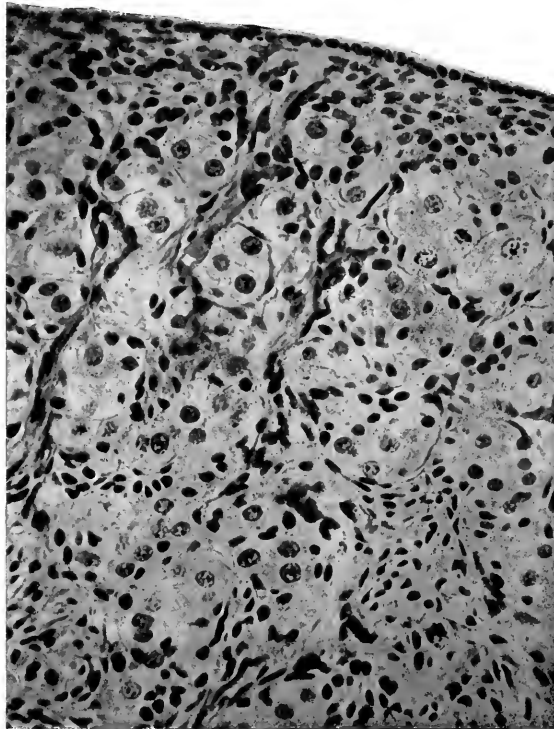


FIG. 42.—Surface of ovary of new-born puppy, showing capsular epithelium and cell-nests. ($\times 300$ diam.)

tubules by means of which the ova are conveyed to the surface of the organ. These columns (as seen in the kitten's ovary) are solid masses of cells surrounded by stroma ;

there is no central lumen. They become broken up into smaller groups and form follicles or interstitial cells. The stroma-cells are fusiform in shape with deeply staining granular nuclei; they vary in appearance at the different periods of ovarian activity.

As development advances the oögonia undergo marked nuclear changes according to their adaptation for the various physiological functions. Four main types of cell may be differentiated: (1) The cells of the *capsular epithelium* which consist of



FIG. 43.—Schematic drawing of cortex of ovary of new-born puppy.

oval cells arranged at right angles to the underlying cells; they are protective in function. (2) The *follicle*-cells which surround the central developing oöcyte, and thus form the *primordial follicle*. These cells are small and are oval in outline, and act as nurse-cells to the

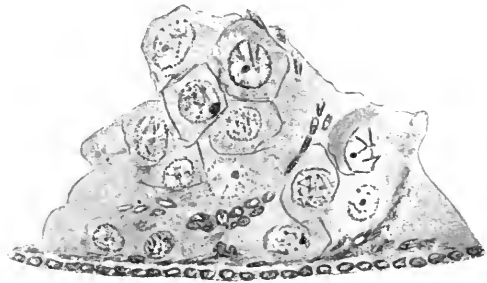


FIG. 44.—Surface of kitten's ovary seventeen days after birth. Stroma-cells are cutting off the capsular epithelium. ($\frac{1}{2}$ Ol. Im. Zeiss.)

growing oöcyte (Fig. 48). Multiplication takes place by direct division, but mitosis has been observed. These cells at first consist of a single row which proliferates and forms several layers, constituting the follicle with its oöcyte. There is much controversy as to the origin of the follicle-cells. Some authors maintain that they are derived from the stroma-cells which they closely resemble in the adult ovary (Wendeler,¹ Clark,² Stevens,³ Williamson⁴). The majority of workers, however, agree as to their origin from the oögonia (Kölliker, Waldeyer, von Winiwarter). Careful examinations of embryonic ovaries at different stages prove that the oögonia group themselves around the oöcyte and thus become follicle-cells. (3) The *reserve cells* are masses of oögonia found chiefly in the medullary zone of the developing

¹ Wendeler, in Martin's *Die Krankheiten des Eierstocks und Nebeneierstocks*, 1899.

² Clark, *Johns Hopkins Hospital Reports*, 1898.

³ Stevens, *Trans. Obst. Soc. Lond.* xlv.

⁴ Williamson, in Allbutt, Playfair, and Eden's *System of Gynaecology*, 1906.

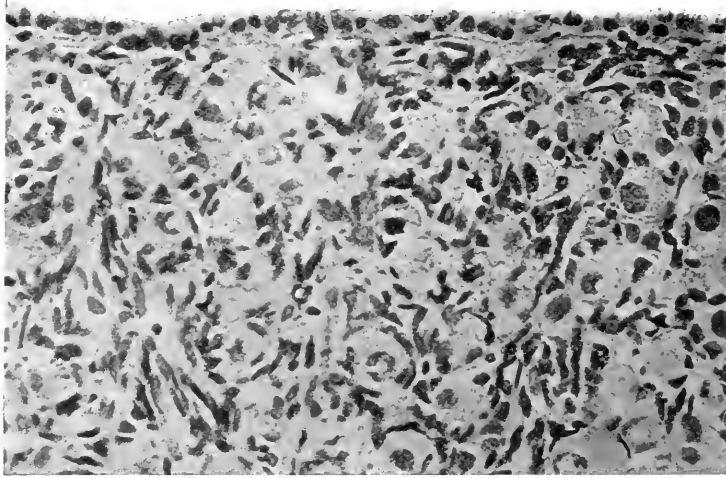


FIG. 45.—Surface of rabbit's ovary, four days after birth, showing capsular epithelium and cell-nests. ($\times 250$ diam.)



FIG. 46.—Ovary of rabbit embryo (26 days), showing differentiation of capsular epithelium. The clear cell in lower part of photograph is in the reticular stage. ($\times 800$ diam.)

ovary. They show progressive and regressive stages of growth. Some are absorbed completely by the growing oöcytes. Some form the future follicle-cells, but they are mainly the source of the *interstitial* cells, which are probably concerned with the internal secretion of the ovary. (4) The *oöcytes* or true germ-cells undergo complicated nuclear changes, and are the only cells which are capable of fertilization (Fig. 47).

The development of the oöcyte may be briefly described as consisting of several



FIG. 47.—Ovary of new-born (human), showing follicle containing two oocytes. ($\times 1000$ diam.)

stages which vary according to the distribution of the chromatin-network in the nucleus. The early cells or oögonia are small and oval with a granular nucleus made up of chromatin filaments. A nucleolus is also to be seen. As development advances the nucleus increases in size, becomes more spherical and clearer, and the chromatin-filaments form a fine reticulum throughout its substance. The nucleolus is not easily defined. Mitosis is well marked. At a given stage mitosis ceases and these cells become differentiated according to their various functions. Those destined to become ova show what is known as the *fine spiral* stage of the nucleus, which is one of short duration. The filaments are spread out over the nucleus in the form of fine

loops and skeins, some of which appear to be in pairs. The next stage is that of *synapsis*; it is prolonged and is of importance, as during this stage the filaments are gathered into a dense skein or mass at one side of the nucleus. Gradually the mass of filaments becomes disentangled and these emerge as thick threads which spread over the nucleus. During this stage the fine filaments may be seen to enter the skein as double threads, and later to emerge as single thick processes. After the filaments emerge they spread over the nucleus and form a spiral—the *thick spiral* stage; this is also somewhat prolonged. Apparent longitudinal division of the filaments now takes place which gives the appearance of parallel pairs. These

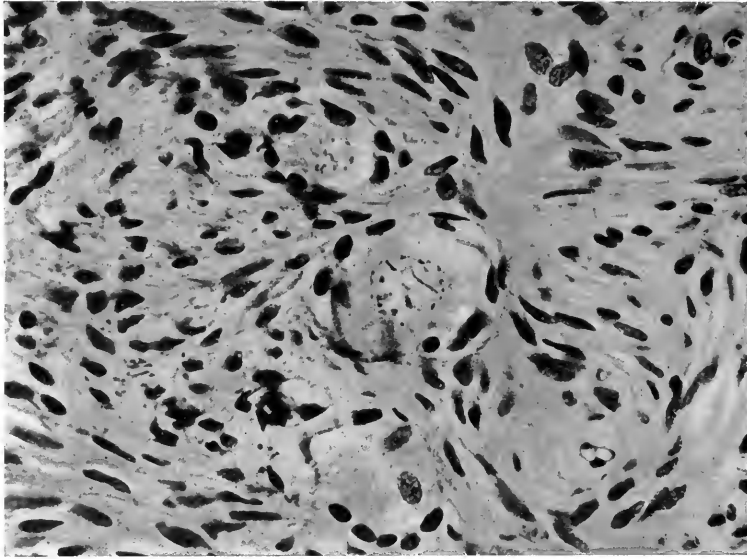


FIG. 48.—Follicles in deeper layers of ovary of three-months-old puppy. Note spindle shape of follicle-cells. ($\times 900$ diam.)

filaments have been in close apposition but complete fusion has not taken place (pseudo-reduction of the chromosomes). During all these stages the cell and nucleus are increasing in size. The nucleus reaches the final or *resting stage* when transverse segmentation of the filaments takes place, and they become broken up to form loops and rings throughout the nucleus. The nucleus is now known as the *germinal vesicle* and the nucleolus as the *germinal spot*. The oöcyte at this stage may remain unchanged for years until fertilization is about to take place. In the human ovary the resting stage is completed before or just after birth. As soon as the oöcyte shows nuclear changes the surrounding oögonia form a ring enclosing it; the whole structure is then known as a *primordial follicle*. Later on proliferation of the follicle-cells takes place, and we have what is known as the *Graafian follicle*. As the oögonia develop they

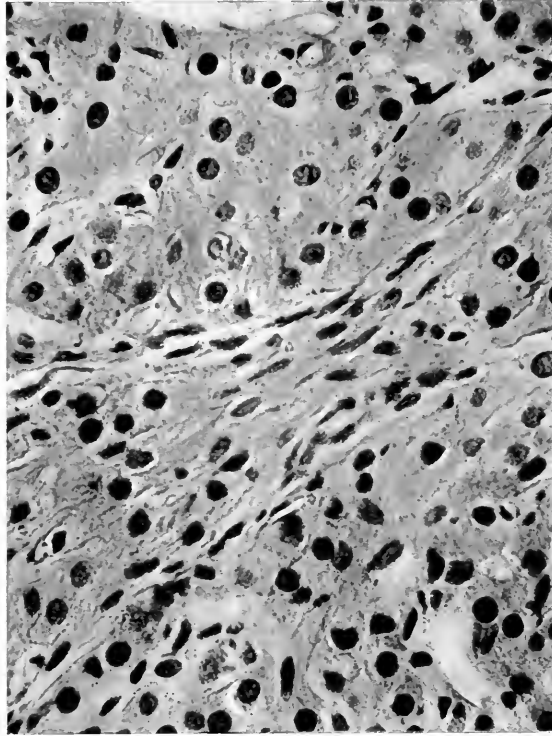


FIG. 49.—Interstitial cells in central portion of cortical zone of new-born puppy's ovary. ($\times 500$ diam.)

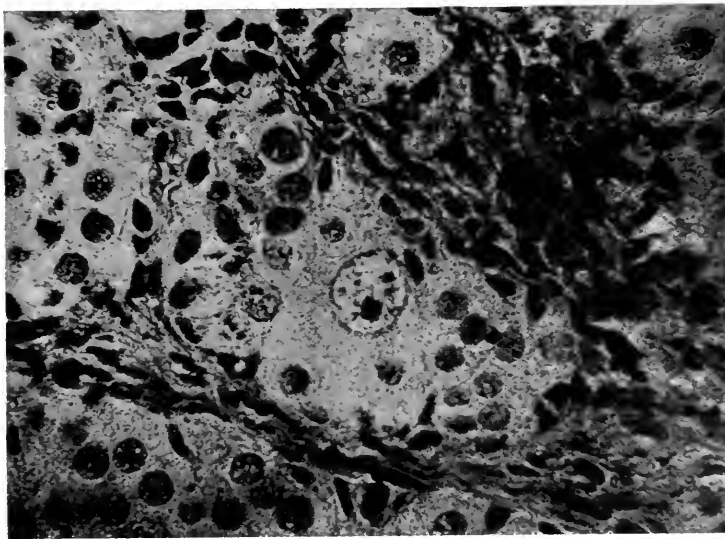


FIG. 50.—Ovary of new-born puppy. Cell-nests with large solitary (giant) cell; from near the surface of the ovary.

gradually sink deeper into the substance of the ovary, the later stages of development being found in the medullary portion. Before its extrusion from the surface of the ovary the oöcyte gradually returns to the cortical zone.



FIG. 51.—Section through a dog's ovary, showing a leash of nerve-fibres passing in from the hilum. ($\times 200$.)

nerves. The nerve-fibres are found lying in great abundance at the hilum of the ovary, where they enter the organ in close association with the blood-vessels. They are arranged in leashes of parallel fibres which show on their course numerous small varicosities (Fig. 51). In the ovarian tissue proper the nerves divide up into three sets—a vascular, a follicular, and an interstitial set.

The *vascular* set of nerves accompany the blood-vessels. They are extremely numerous and form plexuses round the vessels and terminate in connection with the endothelial or muscular coats of the vessel. Where the vessel is close to a follicle, branches may be traced from the vascular nerves to the follicular plexus, in this way establishing a direct

B. STRUCTURE OF THE FULLY DEVELOPED OVARY

The ovary is composed of dense stroma consisting of oval or fusiform cells with protoplasmic processes. Throughout its substance but more especially in the cortical zone are seen numerous Graafian follicles and interstitial cells. In the neighbourhood of the follicles are seen vessels and



FIG. 52.—Section through the ovary of a cat, showing the nerve-fibres in the interstitial tissue, and also a small group of cells in connection with those fibres. ($\times 800$.)

from the vascular nerves to the follicular plexus, in this way establishing a direct

connection between the two sets of nerves. The varicosities described on the nerve-fibres at the hilum are not prominent on the vascular nerves.

The *follicular* nerves pass directly from the hilum to the follicular zone. The fibres take a more or less direct course to the follicles but diverge just as they reach a follicle and become concentrically arranged. The follicular nerves are extremely fine in calibre and are not so numerous as the vascular nerves. Round the follicles the nerves show well-marked varicosities and form a very rich plexus in the tunicae intima and externa. Non-nerve-fibres pass into the membrana granulosa (Fig. 53).



FIG. 53.—Section through a dog's ovary, showing the nerve-fibres lying in the tunicae intima and externa of the follicles. ($\times 400$.)

The *interstitial* nerves, as the name implies, lie in the interstitial tissue of the ovary. They are the least numerous of the three sets, but are yet fairly abundant. On the course of their fibres are numerous varicosities, while at different points groups of very small cells are seen.

These cells are arranged in groups of from eight to twenty, and lie frequently in the neighbourhood of a blood-vessel (Fig. 52). In shape they are oval or racquet-shaped with clearly defined nuclei, and correspond very closely with an ordinary ganglion-cell, except in their size, which is much smaller. Delicate outgrowths seem to pass outwards from them, but their size is so minute that it is difficult to speak with certainty on this point. A rich plexiform arrangement is always seen round these cells, and where they lie close to a blood-vessel or follicle, branches are sent from the vascular or follicular plexuses to join this interstitial plexus. In this way there is a linking up of the three sets of nerves in addition to the connection described between the vascular and follicular nerves.

It is evident, therefore, that the ovary is extremely well supplied with nerves which are distributed most plentifully to the blood-vessels, although both the follicles and interstitial tissue are also well supplied. The three sets anastomose and, therefore, can react on one another.¹

¹ W. Abel, M.D., and A. Louise M'Ilroy, *Proc. Roy. Soc. Med.* vol. vi. No. 7, May 1913 (Obst. and Gyn. Sect.), p. 240.

In the deeper portions are lacunae filled with blood-corpuscles, and dilated vessels. These are derived from the ovarian arteries and veins which enter at the hilum. Remains of the rete tubules are frequently seen. Corpora lutea at varying stages of development are seen in the normal adult ovary.

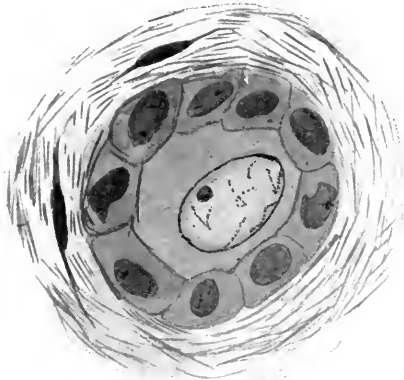


FIG. 54.—Follicle with oöcyte in its interior. Two stroma-cells are seen. (Ol. I. $\frac{1}{2}$ Z.)

Structure of a Graafian Follicle.—As the primordial follicle develops the cells proliferate and form a mass of cells with granular oval nuclei. The cells in the interior of the follicle, by a process of secretion (and it is said also by disintegration), form a quantity of clear fluid—the *liquor folliculi*, which displaces the cells in its immediate vicinity. The oöcyte becomes pushed to one side and carries with it a mass of follicle-cells. Those cells in immediate contact with the cell wall are known

as the *corona radiata*, on account of their radial arrangement. The cells immediately outside are called the *discus proligerus* or *cumulus*. The outer portion of the follicle-cells surrounding the fluid portion constitutes the *membrana granulosa*. Surrounding the latter are dense masses of flattened stroma-cells arranged in layers. By degrees an outer and inner layer are developed—the *theca externa* and *theca interna*.

The thickness of the layers varies with the degree of pressure from the distending follicle. The fully developed oöcyte within the follicle contains a large clear nucleus as already described. The protoplasm of the cell is granular and contains nutritive material or *deutoplasm*. The cell-membrane is well defined; it is transparent, striated, and is known as the *zona pellucida*. The origin of this membrane is controversial. It is thought by some to be derived from the follicle-cells. Before puberty the larger follicles are seen in the medullary portion of the ovary; after puberty they are near the surface where rupture is likely to take place. It is supposed

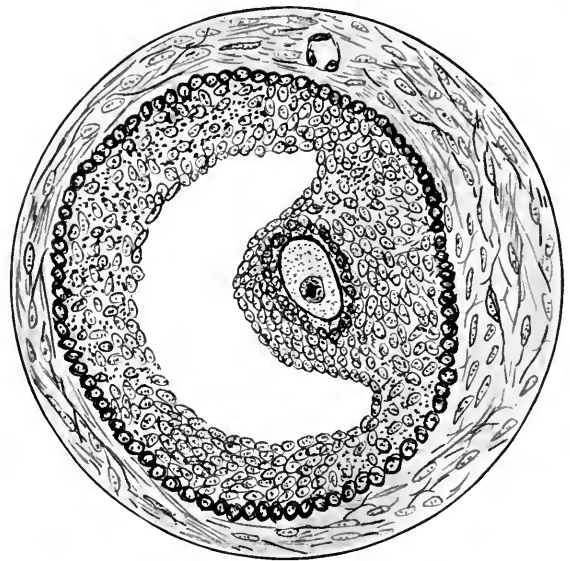


FIG. 55.—Structure of Graafian follicle.

that rupture of the follicle with extrusion of the oöcyte is due to some biochemical changes which take place in the follicle. What is the nature of such changes is unknown. Increased intrafollicular tension, nerve stimulation, and circulatory changes are given as factors in the causation of rupture. The evidence as to the exact nature of the process is unsatisfactory. It is sometimes observed that at one portion of the follicle degenerative changes appear which permit of the rupture and extrusion of the oöcyte with its adherent cells.

The *corpus luteum* is formed subsequent to rupture of the follicle and the discharge of its contents. It is larger in size and in its central portion is found a considerable quantity of clear fluid. In the human ovary the contents are frequently found to consist of blood. Surrounding this are masses of *luteal* cells arranged by means of stroma-ingrowths into festoons, giving a wavy appearance. The luteal cells are granular and are filled with yellowish pigment resembling that of the suprarenal cortical cells.

The luteal cells are said by some to be derived from the stroma-cells of the theca interna, while others claim that they have a common origin with the oögonia. According to Heape the corpus luteum is derived from the follicle-cells and also from ingrowths from the surrounding stroma-cells. It is most probable that the chemical changes, as shown by the deposit of yellow pigment, occur in the follicle-cells, and from them extension takes place to the surrounding stroma-cells. Pigment-deposit has been observed in the interstitial cells in the neighbourhood of a corpus luteum. In short, *the luteal cells are the undischarged follicle-cells* which after rupture undergo considerable hypertrophy. Stroma-cells invade these cell-masses forming festoons. When the oöcyte escapes from the follicle the walls collapse and the cavity becomes filled with blood which is derived from the vessels at the point of rupture and in its vicinity. The corpus luteum is a ruptured follicle filled with blood and follicular fluid, and bounded by a wavy layer of yellow pigmented cells. Leucocytes and stroma-cells early invade the central blood-clot, new blood-vessels are formed, and absorption takes place, leaving a scar. The remains of the corpora lutea are seen in the form of areas having a hyaline or fibrous appearance according to the degree of functional activity of the ovary. Marshall¹ states that in the human ovary, two months after ovulation, only a cicatrix is to be seen as marking the site of a corpus luteum.

The formation of the corpus luteum is closely associated with the premenstrual and menstrual phases; it is known as the *corpus luteum of menstruation*. If fertilization takes place there is persistence of the corpus luteum throughout pregnancy

¹ Marshall, *Physiology of Reproduction*, 1910.

and lactation. This is known as the *corpus luteum of pregnancy*, but it does not differ from that occurring during menstruation. The number of corpora lutea in an ovary is said to correspond to the number of embryos in the uterus but this is open to question, as a corpus luteum may persist for a considerable period under circumstances apart from the fertilization of an ovum or of pregnancy. In some instances the corpora lutea become cystic, and this is said to take place readily in those follicles which are formed before puberty. If development is arrested or rupture of the follicle does not take place, fibrous degenerative changes occur and the contents are gradually absorbed by leucocytes and stroma-cells. These are known as atretic follicles. For further information as to the fate of the Graafian follicle Stevens's paper on this subject may be referred to (*loc. cit.*).

The *interstitial* cells of the ovary are large oval cells (Fig. 49); they are derived from the oögonia and are concerned chiefly with the internal secretion of the ovary and the physiological activity of the other generative organs. They enlarge during menstruation, and also during pregnancy.

SECTION III

A. THEORIES OF MENSTRUATION

Menstruation is the expression of changes which take place in the uterine mucosa, associated with preparations for the reception of a fertilized ovum (Hitschmann and Adler, *loc. cit.*). It is characterized by a discharge of blood from the genitalia, recurring at regular intervals, from the time of puberty until the menopause, except during pregnancy and lactation.

According to numerous authorities, menstruation corresponds to the prooestrus in animals. Fertilization is most likely to take place just after menstruation has ceased, that is at *oestrus* or period of desire. It is quite probable that primitive man had a definite sexual season, and that this has been altered by civilization and environment. Among some of the primates, dioestrous cycles occur, but it is only at a particular season of the year that breeding can take place. According to Marshall there is a marked similarity between the menstrual functions of the various mammalian species. The uterine phenomena vary in the amount of destruction of tissue. Among some animals destruction of the uterine mucosa is not observed, and there is complete absence of haemorrhagic discharge. In the higher monkeys, according to Heape, there is considerable exfoliation of the superficial layers of the mucosa.

Most authors agree that menstruation is a preparation for the attachment of

the fertilized ovum to the uterine wall, but opinion is divided as to the nature of this preparatory process. Menstrual changes are not absolutely essential, as pregnancy may occur either before menstruation has become established, or during periods of amenorrhoea. Hitschmann and Adler believe that the premenstrual period corresponds to those changes which take place at the formation of the uterine decidua; and they therefore look upon it as a preparatory process for the reception of the fertilized ovum. The premenstrual phase is physiologically the most important part of the cycle, the haemorrhagic discharge being of secondary significance.

Bryce and Teacher maintain that the ovum may be implanted at any time during the intermenstrual cycle, and that the menstrual decidua is not a preparation for the fertilized ovum. The function of the menstrual process is to maintain the uterine mucosa in a condition most favourable for the formation of a decidua. The apparent decidual formation is only an over-ripe mucosa undergoing degeneration. These authors agree with Heape that premenstrual and menstrual changes correspond with the prooestrus in animals. In this period conception does not take place. Heape first pointed out that prooestrus alone is the physiological homologue of menstruation. If fertilization should occur then, gestation results. If there is no fertilization, the genital activity gradually subsides, and the mucosa shrinks to its normal or resting phase, *i.e.* anoestrus. According to Metchnikoff many of the disturbances in connection with menstruation may be looked upon as pathological, and in some instances the changes in the genital organs may be injurious to the individual as a whole. This author looks upon the menstrual function as a disharmony of organization, which has been brought about as the result of modifications acquired recently in the history of the species. It has been suggested that the presence of the increased number of leucocytes in the uterine mucosa during the menstrual process is due to some pathological condition. The theory that menstruation occurs as the result of failure on the part of the ovum to be fertilized, is negatived by the work of Heape, who found that among monkeys ovulation occurs during the oestrous period, after the destructive stage is concluded. Observations upon other animals agree with these conclusions, as it is only after the haemorrhagic discharge has diminished or ceased, that fertilization is able to take place. The theory that menstruation is due to the abortion of an unfertilized ovum is disproved in the case of those animals which experience a long interval between the menstrual periods.

Geddes and Thomson look upon the menstrual discharge as a means of disposal of the metabolic surplus which during pregnancy is consumed by the embryo.

It may be accepted that premenstrual and menstrual changes in the uterine mucosa are in the nature of preparation for the reception of a fertilized ovum, and

its embedding subsequently in the uterine wall. But at the same time it must be remembered that the external manifestation in the form of uterine haemorrhage is not essential for the nutrition of the ovum, since pregnancy may occur in women who have never menstruated, and during periods of amenorrhoea, or during lactation. That the menstrual changes which take place in the uterine mucosa are entirely dependent upon the presence of ovarian tissue is now proved beyond dispute by laboratory experiments, as well as by observations of numerous clinicians.

B. CHANGES WHICH OCCUR AT PUBERTY AND THE FACTORS WHICH INFLUENCE MENSTRUATION

Menstruation in the human female is, as a rule, the first indication that sexual maturity has been reached, although the secondary sexual characteristics may be present before the first appearance of haemorrhagic discharge. Individuals are sometimes met with in whom menstruation has never occurred, although they have the appearance of complete sexual development. At puberty there is an alteration in the general metabolism, as the organism is endeavouring to adjust itself to the changes which are taking place in the various internal secretory organs. The nervous system is highly sensitized and the mental condition becomes different. Externally there is a growth of hair in the pubic and axillary regions. The mons veneris and labia become more fully developed, and the prepuce, which was uncovered during infancy, becomes hidden. There is enlargement of the mammary tissue, and more or less fat is deposited, forming rounded outlines. The uterus becomes enlarged, and its body elongates in comparison with the cervix. The ovaries alter in shape, becoming broadened out, and numerous Graafian follicles are to be seen in their structure. Corpora lutea now show signs of formation, and the interstitial cells increase in size. Menstruation may occur at irregular intervals until the normal cycle is fully established. Epistaxis is sometimes observed in girls at puberty, and may even be periodic, replacing the uterine discharge.¹

C. THE MENSTRUAL CYCLE

The whole menstrual cycle, as a rule, lasts from twenty-eight to thirty days, and the period of haemorrhagic discharge occupies about three to four days of this time. It is sometimes observed that a certain amount of metabolic disturbance occurs in the middle of the intermenstrual periods, as though some intrinsic changes were taking place. No definite explanation, however, can be given as to the nature of such changes. They are probably connected with certain processes which are taking

¹ See Article on Disorders of Function, p. 374.—EDITORS.

place in the ovary, such as ovulation or the ripening and bursting of the Graafian follicles. Certain pathological conditions are observed to be accompanied by pain and congestion of the pelvic organs in the menstrual interval, with perhaps a slight muco-sanguineous discharge.

The onset of menstruation usually occurs about the age of fourteen years, but may be modified by climate, nutrition, and occupation. In hot countries the onset is earlier, and also in the case of girls who are engaged in manual occupations. It is found to occur at a later period in tall girls, and earlier in those of short or stunted stature; the increase of stature, on the other hand, may be the result, and not the cause of delay in the onset of the ovarian function. In precocious sexual development, menstruation occurs at an early period of the girl's life. The haemorrhagic discharge which is sometimes observed in new-born infants, cannot be looked upon as menstruation; it is said to be due to the presence of some chemical substances in the placental circulation acting upon the uterus. This condition is to be associated with that of activation of the breasts of the newly born. Menstrual periodicity depends to some extent upon environment and nutrition. Travel, change of climate, or occupation may cause a temporary suppression of the function. In tropical countries the menstrual cycle is shorter than in cold countries.

- The occurrence of amenorrhoea in girls who have migrated from the country to a town, may be looked upon as analogous to the arrest of the reproductive function among animals in captivity, and can only be put down to altered genital metabolism. The amount of the haemorrhagic discharge is estimated at from 2 to 6 oz., but it varies considerably in each individual, depending to some extent upon climatic conditions, occupation, and mode of living.

General Changes which occur during Menstruation.—There is enlargement of the mammae, together with increase in the size of the thyroid and parotid glands. The voice is affected to a certain extent. The skin may show evidence of pigmentation or congestion, and is more prone to take on localized infective conditions, such as the eruptions of acne vulgaris. Nervous phenomena, such as headaches, manifest themselves. If neuroses with mental depression are marked, they must be looked upon as pathological. The pulse rate is usually diminished (Zuntz). Blood-pressure is raised in the premenstrual phase, but it is lowered after the haemorrhagic discharge is established. No constant respiratory changes have hitherto been recorded for the menstrual period. Haemoglobin is said to be decreased. The red blood-corpuscles are increased in number during the premenstrual phase and reduced in the menstrual phase. Coagulability in the systemic blood is diminished during menstruation.

The records of the changes which take place in the nitrogen metabolism during menstruation are too controversial to be of practical value. From some observations made by the author, and as yet unpublished, the most marked changes take place in the premenstrual stage. According to the researches of Blair Bell there is a marked rise in the calcium index of the systemic blood, and an increased output of calcium in the fluid constituting the haemorrhagic discharge.

D. FUNCTIONS OF THE CORPUS LUTEUM AND INTERSTITIAL CELLS, AND THE FACTORS WHICH INFLUENCE THE MENSTRUAL FUNCTION

The corpus luteum is now regarded as a gland having an internal secretion apart from that of the interstitial cells, but whether such a secretion is antagonistic to that of the latter cells is not known. Prenant first drew attention to the corpus luteum as a ductless gland. He stated that it prevents the occurrence of ovulation during pregnancy, and that it has an influence upon metabolism. The corpus luteum was formerly supposed to preserve the circulation of the ovary, and thus prevent the formation of excessive scar tissue. In view of more recent observations, however, the function of the corpus luteum is much more complex. It is quite probable that the nutrition of the ovary is influenced by the interstitial cells.

According to Fränkel¹ the corpus luteum is responsible for a secretion which controls the vascular supply of the uterus, and determines the occurrence of menstruation. In addition it brings about changes in the uterine mucosa which constitute preparation for the embedding of the fertilized ovum, and for the maintenance of the nutrition of the developing embryo until the placenta is fully formed. Fränkel maintains that removal of the corpus luteum prevents the onset of the next menstrual period; and that in cases of early pregnancy abortion follows the destruction or withdrawal of the secretion. In the later months of pregnancy, however, removal of the corpus luteum has no influence upon the nutrition of the ovum. These observations may apply to certain species of animals, such as rabbits, but they cannot be accepted for clinical purposes. Removal of the corpus luteum, even extirpation of both ovaries, has been frequently performed on women during early pregnancy, and abortion has not occurred as a consequence.

In extra-uterine pregnancy, changes take place in the uterine mucosa which must be due to an influence outside the uterus, and not to contact of the ovum with the mucosa. Pathological conditions of the ovum, such as are found in chorion-epithelioma, may be associated with the formation of lutein cysts in both ovaries.

¹ Fränkel, *Arch. f. Gyn.*, 1903, 1910; *Zeit. f. Geb. und Gyn.*, 1910.

That the presence of the cysts has much significance is a matter of question with some authorities. Marshall and Jolly¹ conclude that the corpus luteum is formed after ovulation, the latter usually taking place during oestrus. These authors believe that the gland elaborates an additional secretion which controls the embedding and early nutrition of the ovum in the uterus. Vincent² denies that the corpus luteum induces 'heat,' seeing that in dogs ovulation normally takes place during oestrus. No fully-formed corpora lutea, therefore, are to be found in the prooestrous period, and he concludes that 'heat' is brought about by an internal secretion of the ovary other than that of the corpus luteum. Marshall contends that 'heat' occurs at infrequent intervals in many animals, and in some animals no corpora lutea are to be found in the prooestrus, since ovulation only takes place at the oestrous period.

Loeb³ believes that the corpus luteum sensitizes the uterus and prepares it for the embedding of the ovum. Ancel and Bouin⁴ found hypertrophy of the uterine mucosa in rabbits in which ovulation had taken place without fertilization. Aschner⁵ found a specific lipid substance in the corpus luteum, and confirmed, to a considerable extent, the observations of Fränkel. Injections into guinea-pigs of extracts prepared from this lipid substance caused congestion of the genital organs, and even haemorrhagic infiltration of the uterine mucosa.

Injections of corpus luteum extract have a more marked effect upon uterine contractions than extracts from any other portion of the ovary. It may be accepted that the corpus luteum has a marked trophic influence upon the nutrition of the early ovum, and that this influence is maintained until the placenta is physiologically capable of performing its function.

Histological examination of ovaries removed during pregnancy shows enlarge-

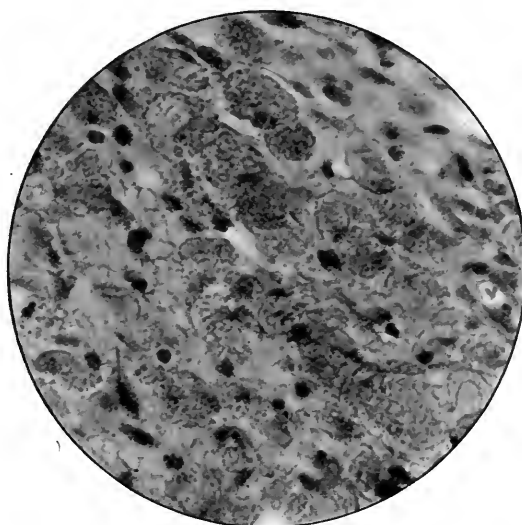


FIG. 56.—Interstitial cells from ovary of dog removed during prooestrus; much enlarged, and cytoplasm filled with lipid substance. ($\times 400$.) (*Proc. Roy. Soc. Med., Obst. and Gyn. Sect.*)

¹ Marshall and Jolly, *Phil. Trans. Roy. Soc.*, 1906.

² Vincent, *Internal Secretions and the Ductless Glands*, 1912.

³ Loeb, *Journ. Amer. Med. Assoc.*, 1909.

⁴ Ancel and Bouin, *Compt. Rend. de la Soc. de Biol.*, 1909; *La Presse Médicale*, 1911.

⁵ Aschner, *Arch. f. Gyn.*, 1913.

ment of the interstitial cells, and development of the corpus luteum (Figs. 56 and 57). There is some controversy in regard to the state of activity of the ovaries during pregnancy, the majority of authors agreeing, however, that there is increase in function.

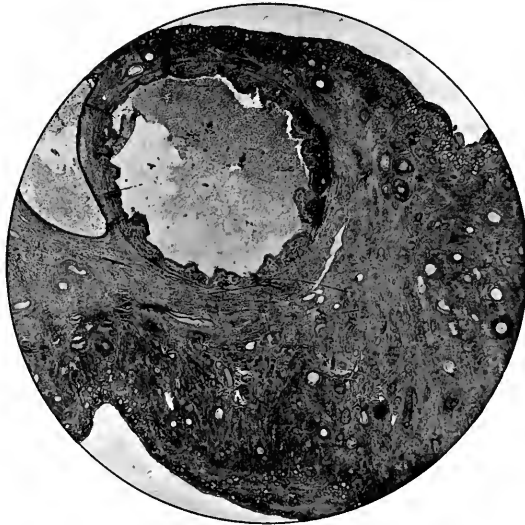


FIG. 57.—Ovary of dog removed during prooestrus. Corpus luteum shown. ($\times 12$.) (*Proc. Roy. Soc. Med., Obst. and Gyn. Sect.*)

Loeb's experiments on mechanical stimulation of the mucosa in recently fertilized rodents show that decidual reaction appears only in the presence of corpora lutea in the ovary. If fertilization has taken place, the corpus luteum goes on developing, but if unfertilized the gland gradually involutes and becomes cicatrized. This lends acceptance to the theory that the main function of the corpus luteum is that of nutrition of the embryo in the uterus. Cases of repeated abortion may be due, in some instances, to degenerative changes occurring in the corpus luteum.

If the X-rays be applied to the ovary they cause atrophy of the Graafian follicles and corpora lutea, with consequent sterility. In cases of pregnancy, however, it has not been found that the application of these rays causes abortion. It is therefore possible that to some extent the interstitial cells are responsible for the maintenance of the nutrition of the ovum. These cells have a marked influence upon the nutrition of the genital organs. In ovarian grafts, if the interstitial cells are present, atrophy of the genital organs is prevented. The persistence of the corpus luteum during pregnancy cannot be looked upon as a necessary deterrent to ovulation and menstruation, as clinically there is evidence of menstruation having taken place during pregnancy, and superfoetation is not unknown among laboratory animals. The corpus luteum when persistent is said to prevent the onset of oestrus and fertilization. Further work is required to elucidate the function of the interstitial cells. Noël Paton¹ considers that these cells in both sexes are a connecting link between the soma and gonads.

¹ Noël Paton, *Regulators of Metabolism*, 1913.

SECTION IV

A. MENSTRUATION AND OVULATION

Owing to the difficulty of an exact determination of the occurrence of ovulation, it is impossible to make definite statements as to the relationship between ovulation and menstruation.

By the term ovulation, we mean the series of changes which takes place in the Graafian follicle prior to and during the extrusion of the central oöcyte on to the surface of the ovary. That menstruation depends upon ovarian secretion is now conclusively proved by its complete cessation after oöphorectomy, and its recurrence in the presence of successful grafts from the ovaries. Experiments have shown that prooestrus may be induced by transplanting ovarian tissue into an animal which has been previously castrated, and in which prooestrous changes have been in complete abeyance. Moreover, if a small portion of ovarian tissue is left *in situ* it is sufficient to prevent the cessation of menstruation. But how far menstruation depends upon the process of ovulation is not as yet clearly defined. The difficulty of the question is shown in discussions concerning the exact estimation of the age of an early embryo (see Keibel and Mall).

Bischoff, Reichert, Williams, and Leopold believe that menstruation and ovulation are synchronous, but that one may occur independently of the other. Bischoff looks upon menstruation as an expression of ovulation. He showed that among rodents ova are extruded during menstruation, and that corpora lutea are formed subsequently and independently of fertilization.

Reichert found on examination of an early embryo and numerous ovaries, that the Graafian follicles rupture at the beginning of menstruation. He concludes that ovulation occurs just before the onset of menstruation. If fertilization takes place the menstrual discharge is arrested. That ovulation precedes menstruation is not proved conclusively. In the methods of estimation of the probable age of an early embryo, the condition of the corpus luteum is taken into account, but there is no definite standard by which we can come to any conclusion. Ovulation may take place at any time in the menstrual cycle, but it is most likely to occur near the premenstrual or menstrual phases, since it is about this time that fertilization most frequently occurs. Ovulation may occur during pregnancy and lactation, *i.e.* when menstruation is in abeyance.

Marshall believes that among dogs ovulation occurs after uterine haemorrhage has diminished or ceased, and may be quite independent of coitus.

Among rabbits it is generally believed that ovulation takes place at the time of coitus.

Pflüger held that the maturing follicle generates stimuli which cause a congestion of the pelvic organs, which in its turn brings about a bursting of the follicle with expulsion of the oöcyte, as well as discharge of blood from the uterine mucosa.

Strassmann¹ found that symptoms of prooestrus could be induced by causing a rise of blood pressure in the ovary. That ovulation occurs independently of menstruation is proved by symptoms of menstrual molimina occurring in individuals where the ovaries are normal but where the uterus is absent or rudimentary. This may be observed after removal of the uterus by hysterectomy. Menstruation may occur in cases of paraplegia, showing that the stimulation of the uterus by the ovary is chemical rather than nervous in character.

Heape made a series of observations upon ovaries of menstruating monkeys but did not find ripe follicles in every case. He believes that oestrus is induced by a generative ferment present periodically in the blood, and that there is also another substance with a specific action which he calls *gonadin*. The mutual relationship of these, however, cannot be explained.

Menstrual haemorrhage may be looked upon as a metabolic process for the excretion of products which are unnecessary to the organism. These products are used up during pregnancy by the developing embryo, and uterine haemorrhage does not, as a rule, take place. The fact (Blair Bell) that calcium is necessary for the economy of the new organism is quite true, but does not fully explain the condition; the process of menstruation is concerned with the elimination not only of inorganic salts but with complex and unknown organic ferments. The generation of the reproductive metabolic products most probably occurs in the ovary, but the uterine mucosa must be looked upon as an organ having a secretion of its own. This will be referred to later.

B. FACTORS WHICH INFLUENCE FERTILIZATION

According to Keibel and Mall, fertilization most probably takes place in the first portion of the oviduct or Fallopian tube, but may in exceptional circumstances occur upon the surface of the ovary. Segmentation of the ovum has already begun in specimens of ova which have been found in these regions. There is also conclusive evidence to be met with in numerous instances of ectopic pregnancy which have been observed clinically, as well as cases of pregnancy in the ovary itself. We must

¹ Strassmann, *Arch. f. Gyn.* lii.

conclude from such evidence that conjugation of the male and female cells occasionally takes place even in the Graafian follicle, but is most usual in the Fallopian tube. It is highly improbable that fertilization takes place in the uterus.

The factors which influence the occurrence of fertilization are hard to determine. The most likely period for the occurrence of fertilization in the human female, as contrasted with the lower animals, is that of the postmenstrual phase. This is the only period when coitus is permitted among many animals, and it is said to be the period of desire in the human species. The least probable period for fertilization to take place is in the intermenstrual phase when the genital organs are in a state of quiescence. It must be remembered, however, that in the human species fertilization has been known to occur at every phase of the menstrual cycle, in so far as the uterine mucosa can never be said to be in a state of absolute physiological inactivity during reproductive life.

The question of the exact date at which fertilization took place is of importance in the estimation of the possible age of an early embryo. We cannot, however, estimate it with any degree of accuracy as far as the menstrual phase or coitus is concerned, since fertilization may occur at varying periods of time after coitus has taken place, and at any period of the menstrual cycle. In the human female fertilization is supposed to be possible only after the onset of puberty, but numerous examples have been recorded where impregnation has occurred at a much younger age, *i.e.* before the reproductive organs could have attained to their full maturity. It is generally supposed that the number of embryos in the uterus correspond to the number of corpora lutea in the ovaries, and that in those animals in which gestation is prolonged, the number of the offspring is much less than in those where gestation is of short duration and of frequent occurrence, *e.g.* in the rabbit. The number of the mammae also indicates to a certain extent the limitations in the number of the offspring.

Fertility is greatest in women between the ages of 20 and 30 years ; after that period has been reached, it gradually decreases until the menopause is passed. Fertility is influenced to a considerable extent by nutrition and environment. Excessive feeding and extreme malnutrition are prejudicial factors. Ovulation is said to be diminished in animals living in captivity, since sterility is frequently met with, more especially among carnivora. The excessive feeding of cattle for agricultural purposes is said to induce sterility. Prolonged lactation in women is said to diminish the probability of conception ; that it does not render it impossible numerous examples of pregnancy demonstrate. Failure in ovulation may prevent fertilization taking place by arrest in the development of the Graafian follicles and

the formation of atresic follicles. Such a condition is due to alterations in the genital metabolism. Persistence of a corpus luteum may cause sterility in the human female, just as it does among cattle. Unruptured follicles are frequently observed in sclerosis of the ovaries.

The question of sterility will be discussed in its own section (see p. 404¹), but leaving aside all known pathological causes there is no doubt that there is a vast field for investigation into the physiological processes which take place in connection with ovulation and fertilization. It is only with an accurate knowledge of these processes that we can seek to investigate the causes of failure in fertilization in individuals who have never been the subjects of any congenital defect or pathological lesion. It must be borne in mind, in our consideration of the factors which influence fertilization, that the internal secretory organs as a whole may be responsible. In those conditions in which there is deficiency or excess of thyroid or hypophyseal secretion, ovulation may be interfered with; *e.g.* in cases of goitre or acromegaly, sterility is of frequent occurrence. The chemical alterations which the uterus undergoes may be responsible for failure in fertilization, as it has been found that excessive acid-reacting secretion from the uterine mucosa may prevent impregnation, either by its direct effect upon the spermia or upon the early ovum itself.

SECTION V

A. INFLUENCE OF OVARIAN SECRETION UPON DEVELOPMENT AND GROWTH

At puberty or sexual maturity various phenomena which are synchronous with changes occurring in the ovary, such as ovulation and the formation of corpora lutea, are ascribed to the presence of ovarian secretion. These changes are first observed at puberty, they persist throughout reproductive life, and gradually disappear at the cessation of ovarian activity. Proof of the influence of ovarian secretion as a factor in the production of sexual maturity is to be found in experiments for removal of the ovaries before or after the onset of puberty; and also in the transplantation of ovarian tissue. At puberty there is development of the so-called secondary sex-characteristics, such as rounding of the curves of the body, enlargement of the mammae, growth of hair in the pubic and axillary regions, increased development of the genital organs, together with the onset of menstruation and its accompanying phenomena. Changes in the ossifying cartilages of the bones are found, together with enlargement of the thyroid and pituitary bodies. The thymus shows regressive changes as soon as the genital functions become fully established. Psychological changes also are

¹ Article on Disorders of Function, p. 404.

observed; the mind and character of the child being transmuted into those of the woman.

If both ovaries are removed before the onset of puberty, as has been done for experimental purposes in animals, it is found that there is an arrest in the normal development of the genital organs and mammae. Prooestrus or menstruation, and its accompanying phenomena are in abeyance. The growth and nutrition of the individual are however unaffected by the experiment. The same result is to be found in cases of removal of ovaries in children for some definite pathological condition. Biedl¹ states that castration in males causes a delay in the ossification of the long bones, as is seen in eunuchs. Delayed menstruation is observed more frequently in tall girls, and precocious menstruation in those of short stature.

The effect of the removal of the ovaries after puberty is not so marked, since development has already taken place. Atrophy of the uterus and other genital organs sets in; whilst microscopical examination of the uterine wall shows degenerative changes resembling those of fibrosis (Fig. 58). The glands of the uterus disappear eventually, the blood-vessels diminish, and finally the surface epithelium becomes completely absorbed. Menstruation no longer takes place. These changes are due to the removal of ovarian tissue and not to interference with the vascular or nerve supply. A small piece of ovary if left in position will serve to prevent the onset of the atrophic changes. Atrophy of the genital organs occurs as a normal consequence of the menopause, ovarian secretion being no longer active. Removal of one ovary causes hypertrophy of the remaining organ, irrespective of the onset of oestrus or pregnancy. During early pregnancy, according to the researches of Fränkel, the removal of both ovaries causes abortion to take place. This statement is open to criticism in view of later researches and observations, more especially with regard to the human female.

Influence of Ovarian Secretion upon Pregnancy.—The histological examination



FIG. 58.—Transverse section of uterus of a monkey four hundred days after oöphorectomy. No muscular tissue or glands present. Wall composed of fibrous tissue. The epithelium lining the uterus is present. (*Proc. Roy. Soc. Med., Obst. and Gyn. Sect.*)

¹ Biedl, *Die innere Sekretion*, 1903.

of ovaries which have been removed during pregnancy shows enlargement of the interstitial cells and formation of corpora lutea. The enlargement points to increased function on the part of the tissues, and agrees with the statements of Fränkel as to the importance of the presence of the corpus luteum during pregnancy. The increase in the length of the long bones, and the increased deposit of fat in young women during pregnancy, is taken by some as proof of a decrease in the amount of ovarian secretion. That the corpus luteum has a marked influence upon decidual formation has been shown by the experiments of Loeb. Vincent believes that the corpus luteum is an essential factor in maintaining the nutrition of the uterus and ovum during early pregnancy. The interstitial cells have doubtless a trophic influence upon the ovum, but the nature of such an influence has as yet to be proved.

Influence of Ovarian Secretion upon Metabolism.—Very little is known with regard to the metabolic changes which take place as the result of alterations in the reproductive functions. Investigation has been restricted chiefly to observations upon animals before and after oöphorectomy, in addition to those upon the period of menstruation as it occurs in the human female. Many statements as to the metabolic changes are unreliable, the observations being very inadequate.

After castration of an animal of either sex there is a tendency to a deposit of fat, and the respiratory exchanges are decreased. Administration of ovarian extract has been found by some observers to counteract this tendency in women. The evidence as to the influence of the ovaries upon the calcium and phosphorus metabolism is somewhat conflicting. After castration there is an increase in the long bones if the operation be performed before ossification of the centres is complete. In osteomalacia there is a decalcification of the bones, and it is held that this is due to some abnormal function on the part of the ovary; such an assumption being based on the record of cases which have been cured of the condition by the performance of oöphorectomy. This, however, in the light of our increased knowledge of the function of the other endocrinous organs, is open to doubt. In pregnancy a certain amount of change occurs in the bones, more especially in those of the pelvis. During lactation there is a marked change in the output of calcium, as milk contains a large amount of this substance. After oöphorectomy the calcium output is said to be diminished, but this statement is controverted by several workers. The records of observations upon the nitrogen metabolism are very contradictory, but there is no doubt that ovarian secretion has an effect, as witnessed by the marked symptoms of metabolic derangement which occur in the premenstrual and menstrual phases. It is difficult, with the scanty information at our disposal, to do more than assert that the reproductive organs exert an influence upon metabolism; we must wait until more

researches have been made into the functions of the internal secretory organs, and the relationship which exists between secretion for general nutritional purposes, and that for reproduction alone. During menstruation there is a drop in the calcium index of the systemic blood with increased output in the menstrual fluid (Blair Bell). Coagulation of the systemic blood is said to be retarded during menstruation. The most marked changes in metabolism are found to take place in the premenstrual phase, as it is during this phase that the ovarian secretion is most active. Observations upon the increase or decrease of the red blood-corpuscles during menstruation are contradictory. After oöphorectomy in women, there are frequently to be observed marked vasomotor changes, and also occasionally psychological derangements. There is sometimes an increased deposit of adipose tissue. At the normal menopause these phenomena may be observed.

B. TRANSPLANTATION OF OVARIES

That the ovary resumes its functional activity when transplanted on abnormal situations, is proved by the investigations of numerous workers (Marshall, Jolly, Limon¹) carried out upon laboratory animals, and by the observations of Tuffier² in the course of his operative work upon the human female. It has been found that the grafted tissue, in those cases in which transplantation has been successful, retains the functions of the original organ. Proof of this is supplied by the fact that in these cases atrophy of the genital organs is prevented, and there is no cessation of menstruation or proöestrus.

Some observers have found that ovulation occurs in the grafted tissue with the formation of corpora lutea. Knauer³ has shown in the case of the rabbit that pregnancy may occur. It is doubtful whether this holds good in the case of the human species, although some evidence is furnished by Morris⁴ who published a case of

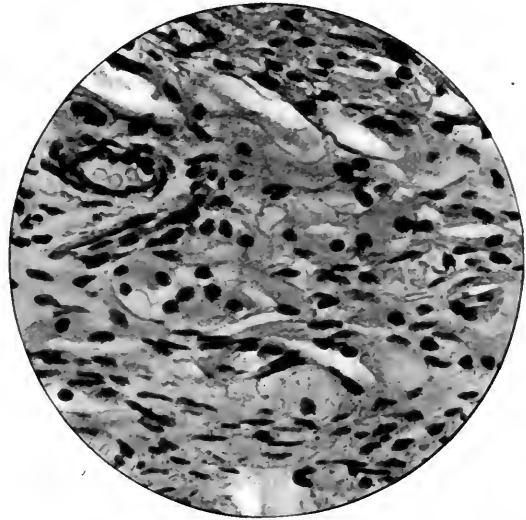


FIG. 59.—Interstitial cells (normal) from ovarian graft. Seventy days after graft-operation. No atrophy of uterus, but follicles cystic. ($\times 400$ diam.)

¹ Limon, *Journ. de Phys. et de Path. Gén.*, 1904.

² Tuffier, *Rev. de Gyn. et de Chir. abd.*, 1912; *Journ. de Chir.*, Paris, 1913.

³ Knauer, *Zeit. f. Gyn.*, 1896; *Arch. f. Gyn.*, 1900.

⁴ Morris, *New York Med. Journ.*, 1895, 1906.

pregnancy occurring after transplantation of ovarian tissue. In monkeys menstruation ceases after oöphorectomy, but has been found to become re-established after the grafting of ovarian tissue. Most authors, however, agree that a certain amount of degeneration takes place in the grafted tissue, and that the permanent benefit is open to question. The whole subject of ovarian grafting is still in the experimental stage, and we cannot hope to obtain much definite or reliable information on it until we have reached a more accurate estimation of the chemical composition of the ovarian secretion itself.

There is still controversy in regard to the question of the particular elements in the ovary which are essential for the maintenance of physiological activity. The presence of follicles, and the continuance of ovulation seem to be regarded as the factors which have the greatest influence upon uterine nutrition. The author's own experiments, however, have gone to show that the presence of the interstitial cells is necessary for the continuance of ovarian function. This has been observed also by Limon. Atrophy does not take place when the interstitial cells are present in the graft, even though the follicles be absent. Further experimental work is necessary in order to enable us to differentiate between the functions of the various structures of the ovary.

It has been shown by Steinach,¹ from his work on rats, that transplantation of ovarian tissue upon castrated males is followed by the assumption of female characteristics, such as enlargement of the mammae and changes in the skeletal structures. Such results point to a specific action on the part of the secretion of the male and female gonads. Steinach attributes these changes to the presence of the interstitial cells as distinguished from the follicles, since atrophy of the latter may be met with in the graft.

Marshall and Jolly found that grafts from the same animal are more successful than those from another individual. Grafts from animals of the same litter give better results than in non-consanguineous animals. Previous castration of the host renders grafting more successful. It has been found that the transplantation of ovarian tissue from an animal of one species to one of another species (*heteroplastic graft*) is doubtfully successful, and that the nearer the relation of the two animals the better the results. Guthrie's² extensive transplantation experiments on fowls show the influence of the grafted gonads upon the offspring. Among the mammalian species, however, no conclusive proof is to be found.

There is no doubt that a considerable number of workers have proved experimentally that it is possible to transplant ovarian tissue successfully with the object

¹ Steinach, *Pflüger's Archiv*, 1912 ; *Zeit. f. Phys.*, 1913.

² Guthrie, *Journ. of Exper. Med.*, Lancaster, Pa., 1910 ; *Journ. of Exper. Zool.*, 1908.

of maintaining its function. But the grounds for applying these observations to clinical gynaecology are at present somewhat inconclusive. In the human female transplantation of ovarian tissue has been performed by surgeons in order to prevent the onset of post-operative menopausal symptoms in cases in which removal of both ovaries is imperative. It is doubtful whether the menopausal symptoms are due to suppression of ovarian secretion, or to the atrophic changes in the uterine mucosa which occur after the cessation of menstrual discharge occasioned by removal of the ovaries. Tuffier in his observations upon 130 clinical cases found that menopausal symptoms were prevented or modified by transplantation of ovarian tissue, whether autoplasmic or heteroplasmic. He found also, that the menopausal symptoms were much modified if part of the uterus were left behind, and he argues from this that the ovary is a link between the uterus and a toxin circulating in the blood. The toxic body having caused ovulation to take place is eliminated by means of the uterine mucosa. Menopausal symptoms were found to be much more pronounced if the uterus had been completely removed. The general opinion existing at present is that ovarian grafts are of value in so far as they tend to mitigate the onset of post-operative menopausal symptoms, and help to maintain the equilibrium of the internal secretory organs. The grafts act more successfully if a portion of the uterine mucosa be left behind.

This is in agreement with the theory that the uterine mucosa serves as the channel for the excretion of metabolic products generated by the ovary either in its normal situation or when engrafted elsewhere. For practical purposes therefore grafts should be employed in cases of operation for complete removal of the ovaries in women during reproductive life. In cases of inflammatory conditions of the pelvis where the ovarian tissue is much degenerated, or where the recurrent physiological congestion, associated with ovulation in the neighbourhood of infected organs, causes pain and discomfort, the ovary may be transplanted to a non-infected region. Also where there is complete destruction of ovarian tissue through pathological changes, ovarian tissue from a healthy individual may be employed as a graft. It is always very doubtful, however, if the grafts from one individual to another will be successful owing to the multiplicity of the factors which must be considered, such as the character of the blood and the absence of consanguinity in the individuals concerned. It must be remembered that we are still in the experimental stage as regards such operations, and that beyond the work of Tuffier we have little conclusive evidence upon which to rely. Records have been published of cases in which atrophic changes have not occurred after such operations, but the return of menstruation has not always been alleged and the occurrence of pregnancy is more than doubtful.

In view of the experimental results as to the enlargement of a fragment of ovarian tissue when left *in situ*, and the assumption on the part of this remnant of the function of the whole organ, it is surely advisable that we should conserve the ovary in its normal situation when possible, rather than rely upon its resumption of function when transplanted to other sites. Many experimental observers have noted the number of grafts which at varying intervals have shown signs of degeneration, such as atrophy or cyst formation; and it is open to question whether these grafts do not become completely absorbed in time.

For clinical purposes, one or two small portions of the cortex of the ovary are removed and first placed in warm sterile solution and then implanted into the situation which has been selected. It has been found that implantation of the whole ovary has been less successful than when small portions of the organ are employed. Grafts are usually planted in the abdominal wall in the region of the recti muscles or peritoneum, and fixed by ordinary suturing material. In this region a certain amount of control can be exercised over the graft, and the region is easily accessible for its removal should any pathological changes take place in its substance. It is hardly necessary to mention that strict asepsis is essential in the manipulation of such grafts. Implantation may be performed in any of the tissues, such as the uterus, or broad ligament and peritoneum covering other organs. It has been found experimentally that grafts are successful when implanted upon a vascular organ, such as the kidney or spleen. For clinical purposes the manipulation of such organs is associated with some difficulty, and haemorrhage may complicate the operation. Ovarian tissue should be transplanted from one individual to another within as short a time as possible, although Tuffier claims successful results from the use of grafts which have been stored at a low temperature for some considerable time. The younger the patient the more successful is the grafted tissue. The physiological activity of transplanted ovarian tissue serves as a proof that the ovary is an organ of internal secretion, independent of its vascular or nerve supply. Records of cases in which pregnancy has occurred after transplantation of ovarian tissue from one individual to another should be taken with reserve, as it may be found that the condition is due to incomplete removal of the original ovarian tissue rather than to a successful graft.

Pain is sometimes experienced at the site of the graft, and is described by some patients as being cyclic in character, which would indicate that ovulation is taking place in the grafted tissue. If grafts be examined some time after operation it is often found that there is evidence of fibrosis and cystic changes particularly marked in the follicles. Well-formed corpora lutea have been found by some observers. We

require further evidence in regard to the maintenance of ovarian function following upon transplantation of a piece of tissue, and we must not estimate the success of a grafting operation solely from the absence of degenerative changes in the tissue examined microscopically.

Ovarian Extracts.—Although considerable work has been done upon the effects of the administration of ovarian extracts, the results are very contradictory and do not give the satisfaction that has been obtained from work upon extracts of other internal secretory organs. The explanation probably lies in the fact that the ovary is constantly changing its chemical composition, and that it is difficult to find the most suitable period for the preparation of an extract. With the ever-changing growth of follicles and corpora lutea the chemical composition of the tissue is variable, and the period of greatest therapeutic value for an extract has not been ascertained. During ovulation and prooestrus there is a marked change in the histological appearance of the ovary, and it is probable that striking chemical alterations take place in its composition at this time. There is a difficulty therefore in estimating the exact time for the preparation of an extract. Preparations of the corpus luteum are so far said to give the best results, but if the interstitial cells are to be considered as an essential factor in the production of ovarian secretion, a still more potent extract may be prepared from them. Some experimental workers maintain that extracts of the corpus luteum when administered to castrated animals prevent atrophy of the genital organs, but this is denied by Carmichael and Marshall. It was found by Marshall that the extract of an oestrous ovary when injected into an animal in the anoestrous state caused transient symptoms of heat. Negative results were obtained if the extracts were prepared from an anoestrous ovary. According to the experiments of Bell and Hick¹ the injection of ovarian extracts caused marked contractions in the menstruating uterus, but not in the quiescent organ. Contractions in the pregnant uterus were also stimulated. It is said that the administration of corpus luteum extract during pregnancy is contra-indicated. During gestation the corpus luteum is said to be more stable in its chemical composition, and it is therefore advised by some workers that this period should be employed for the preparation of extracts. Administration of ovarian extract causes hyperaemia of the genital organs, and it has therefore been employed in the treatment of amenorrhoea or scanty menstruation, and in sterility.

It is also of benefit in the treatment of menopausal symptoms, more especially those that are the result of operative removal of the ovaries. In cases of ovarian insufficiency it is sometimes given with the view of compensating for the loss of activity, or of stimulating the already existing tissue.

¹ Bell and Hick, *British Medical Journal*, 1909.

We look to the future for the discovery of an ovarian extract containing some active principle which will ensure steady and possibly permanent results. The explanation of the failure experienced by numerous workers is that preparations from the ovary, which undergoes such variations in its physiological activity, must necessarily vary in their chemical reactions. Until some substance is isolated which can be proved to have a definite chemical composition, such as is the case in the extract of the adrenal gland, we cannot expect to have any degree of uniformity in our results.

C. SECONDARY SEX-CHARACTERISTICS

The development of the secondary sex-characteristics is to a certain extent dependent upon the presence of the genital glands, but it is also closely associated with the other internal secretory organs and the maintenance of their normal equilibrium. When an animal reaches sexual maturity, it as a rule assumes characteristics which markedly differentiate the male from the female; previous progress being mainly concerned with growth of the individual, and not with differentiation of sex. The source of the stimulus for this differentiation, however, is a matter of some controversy. There is no doubt that castration-experiments upon sexually immature animals demonstrate that castrated animals do not develop completely as far as their genital organs are concerned, and that they tend to retain the infantile or neutral type. In females, castration causes arrest of development of the genital organs and mammariae, that is, those organs which are destined mainly for reproductive purposes, and which act under the stimulus of ovarian secretion. Therefore in the absence of the normal stimulation, and the consequent diminution in functional activity of the remaining genital organs, the characteristic feminine attributes may to a certain extent be modified. It has not, however, been proved conclusively that these attributes are replaced by the assumption of male characteristics. The individual does not become masculine in character, but if castration is performed before puberty the permanent characteristics are those of the infantile type. If removal of the ovaries takes place during adult life, although there are changes in the nutrition of the uterus and other genital organs, and also in the metabolism as a whole, there is no change in the sex-characteristics as these have been already established. Records of cases of women who acquire masculine attributes after oöphorectomy cannot be taken as proof that the withdrawal of ovarian secretion is solely responsible, as in such cases the pathological factors which necessitated the operation may influence to some extent the other internal secretory organs. It is most probable that the secondary sex-characteristics have their destiny established at the segmentation

of the ovum when the sex-cells themselves are laid down. Subsequent interference modifies but does not obliterate the sex of the individual, or cause the assumption of the characters of the opposite sex. In defective sex-development various abnormalities may be met with, such as lengthening of the long bones, owing to delay in the ossification of the epiphyseal cartilages.

Castration of young male animals leads to persistence of the infantile type, such as high-pitched voice and deposit of fat together with elongation of the bones. These individuals appear to differ from the normal male type after sexual maturity has been reached, but it cannot be assumed that they are feminine in type. They are rather of the infantile or neutral type. Among male animals castration prevents the growth of bones in young lambs, and of antlers in stags. In birds the male plumage is not assumed. In female deer, castration or disease of the ovaries may be followed by development of horns. The assumption of male characters after ovarian influence is withdrawn, as in old age, is the assumption of characters which may be taken as common to both sexes of the species, showing that ovarian secretion tends to inhibit their occurrence. In the male animal the manifestation of their presence is stimulated by the male gonad. In view of the deficiency of scientific knowledge on the subject, we must not take the record of cases which may be looked upon as exceptions or freaks as proof of statements. Steinach's experiments are of interest in that he maintains that he is not only able to induce the characteristics of the opposite sex by grafting ovaries or testes upon previously castrated young animals, but that he obtains similar results when adult animals are employed. We shall require further confirmation from other workers, however, before accepting his experiments as proof that the whole characteristics of one sex depend upon the presence of its corresponding gonad.

The appearance of the secondary sexual characteristics has, as a rule, its incidence at puberty, that is the period which corresponds with the beginning of functional activity upon the part of the gonads themselves. We, therefore, assume that the latter have a marked influence upon the individual organism as a whole. Removal or suppression of gonad-secretion causes a modification to some extent, and results in the retention of the infantile type of the individual. The assumption of the characters of the opposite sex may be observed in some individuals but is not a common consequence of suppression of gonad-secretion. According to Heape¹ the characteristics of each sex are to be found in every individual, one only being fully developed, and he believes that in the female the ovary exerts an inhibitory action upon the male characteristics. Weiniger

¹ Heape, *Quart. Journ. Micros. Soc.*, 1900; *Proc. Roy. Soc.*, 1905.

believes that the male and female characteristics coexist, but unequally, and that an individual is rarely wholly male or female. Among human individuals there are gradations of sex, since we have examples of effeminate men and masculine women, although, as far as the reproductive organs are concerned they are normally developed.

Against the theory that the gonads alone are responsible for the secondary sex-characteristics, we may use the argument that the other internal secretory organs play an important part in influencing sex-development by maintaining the equilibrium of the organism. In proof of this is put forward the example of women, who, to all appearances, are of the feminine type and yet on examination show the presence of testes instead of ovaries. It may be that here the other internal secretory organs have some unknown influence. So far such cases have not been given any concise explanation. Bulloch and Sequeira showed that the adrenal cortex was largely responsible for sex-characteristics. Glynn¹ collected numerous data to prove that tumours of the adrenal cortex occurring in boys caused precocious sex-development of the male type; but occurring in girls the sex-characters were those of the male type also. Precocious sex-development of the female type in girls was brought about by the presence of pathological growths in the ovary alone. It is said that imperfect sex-development is associated with deficiency in the amount of the adrenal cortex. If the physiological activity of the thyroid or pituitary bodies is deficient, as in cases of atrophy or tumours, the reproductive organs may be found in some cases to be infantile as in cases of giantism or acromegaly. Marshall found that implantation of gonads upon animals of opposite sex was a failure, and he believes that the internal secretion of the gonads is operative only in the presence of a responsive metabolism, without which their influence on the organism is ineffective, even though they succeed in becoming attached.

The assumption that sex-characteristics depend upon any definite tissue is not proven. It seems a more feasible theory that at the conjugation of the gametes (or even earlier, as is believed by some authorities who maintain that there are male and female ova and spermia) when sex itself is determined, these secondary characters are also determined, and that in some individuals, according to the variation in metabolism, the character of one sex will be assumed without much secondary influence. In others where the equilibrium between dominant and recessive sex is less stable, the internal secretory organs have an influence upon the development of sex at puberty. This theory of dual sex-potentiality has much to commend it, and explains the dominance of the male type when the stimulus of ovarian secretion is removed, as in old age. The character of an organism is associated with its peculiar

¹ Glynn, *Quart. Journ. of Med.*, 1912.

metabolism, and not with any special cell-substance which may influence it in conjunction with other factors. Derangements of metabolism may cause development in the recessive sex-characteristics at the expense of the dominant. The dominance of one over the other may be decided at an early age of development in response to an external or internal stimulus.

By *pubertas praecox* we mean the early manifestation of sexual maturity before the normal age of incidence. In boys it is usually associated with development of the external genitals, growth of hair, and arrest in development of the long bones. In some cases it is due to tumours of the testes, in others to changes in the suprarenal cortex. In girls there is enlargement of the mammas, growth of pubic hair, thickening of the bones, and menstruation may be present. The condition is supposed to be due to hyperplasia of the ovarian tissue alone, as according to Glynn tumours of the suprarenal cortex in girls lead to diminution of the sex-characters, or to sex-abnormalities. Noël Paton explains the condition of precocious puberty as being due to excessive development of the gametic cells, as a consequence of the withdrawal of the influence of the interstitial cells from the soma to the gametes, the interstitial cells forming the connecting link between the soma and the gonads. Delayed sexual development may be due to defective metabolism, and to involvement of the internal secretory organs.

D. THE MENOPAUSE

In the female the termination of active reproductive function occurs at a more or less definite period of life. This period is called the menopause or climacteric. The cessation of function is due to the diminution, and eventually to the complete cessation, of ovarian secretion. This occurs in the human female about the age of forty-five years, but is variable for individuals and for races. The phenomena associated with cessation of genital function may manifest themselves for a short period of time or for a number of years. In some women there is very little indication that the menopause has taken place.

The chief signs and symptoms may be classified as local and general. The *local* signs are confined to the changes which take place as a result of the cessation of the physiological function of the reproductive organs, such as atrophic changes occurring in the uterus, ovaries, and external genitals. The mammary tissue also becomes atrophied, but this change may not be evident, owing to the increased deposit of fat which frequently occurs at this period of life. The changes in the uterus resemble very closely those which take place after removal of the ovaries, viz., the glandular elements disappear, the whole organ shrinks in size and becomes more sclerosed.

Contractions and occlusions sometimes take place in the whole genital canal. The vaginal fornices disappear and the cervix shrinks. The external genitals become



FIG. 60.—Ovary of young rabbit seventy-five days after hysterectomy. Follicles in all stages of development. Corpora lutea seen. (*Proc. Roy. Soc. Med., Obst. and Gyn. Sect.*)

atrophied, the elastic tissue disappears, and secretion ceases. The ovaries become fibrosed, and their surfaces are covered with the scars of ruptured follicles and corpora lutea. At the approach of the menopause, menstruation may become irregular, with longer intervals between the periods. In some individuals periods of amenorrhoea are succeeded by frequently recurring periods of profuse haemorrhagic discharge. The normal rhythm of the menstrual cycle is lost. In some cases menstruation is perfectly regular and then suddenly ceases.

Functional disturbances affecting the general organism are frequently to be

observed at the menopause. The most important of these are vasomotor derangements, such as flushing of the skin, with alternate sensations of heat and cold. Nervous and dyspeptic symptoms may be present, together with varying degrees of mental disturbances. If such symptoms appear to be marked in their severity, we must seek for some pathological factor, as they are beyond the bounds of physiological metabolic disturbances. The cessation of sexual function in women is not followed by the acquisition of male characteristics, although evidence may appear of a tendency to revert to a common or neutral type, such as growth of hair on the face. Many changes which are attributed to the menopause in the female are common to both sexes, and are due to commencing senescence, such as changes in the structure of the skin and in the bones. Although there is little, if any, scientific knowledge of the definite metabolic changes which take place at the menopause, it is generally accepted that the alterations resemble closely those which may be observed after removal of the ovaries. It is somewhat difficult to determine in any way by observation, the exact changes which do take place, owing to the considerable period of time over which the menopausal symptoms extend. The onset of the symptoms, as a rule, is very gradual and not accompanied by marked metabolic derangements which could be measured by any laboratory tests. The changes which the uterine mucosa periodically undergoes come to an end, and as a consequence this organ

loses its function as a channel for the excretion of metabolic products. There is difficulty in solving the question, as to whether the ovary first ceases in its physiological function, or whether the mucosa fails to excrete the products of metabolism which are generated by the active ovary. The retention of the products of the internal secretion gives rise to symptoms of toxæmia which may be manifested by means of the vasomotor or other nervous systems. In some cases of amenorrhoea near the menopause, and those in which metabolic disturbances are present, patients frequently declare that if the menstrual period returns they are relieved of their symptoms to a considerable extent. This may be taken as evidence of disturbances occurring in the uterine mucosa. The whole endocrinous system is involved at the menopause, and disturbances may take place in not only one organ, such as the ovary, but in several. The beneficial administration of thyroid extract for menopausal symptoms proves that there has been a loss of co-ordination in the internal secretory organs. Menopausal symptoms as a rule subside as soon as metabolic readjustment becomes established. Atrophy of the reproductive organs may, however, continue for some considerable time afterwards. After the menopause it is observed that in some individuals there is an increased deposit of fat.

SECTION VI

FUNCTION OF THE UTERINE MUCOSA

It has been stated that the uterus by means of its secretions maintains the functional activity of the genital organs, and that the results of oöphorectomy are due to the interference with the vascular and nerve supply of the uterus. Atrophy of the ovaries is said to take place after hysterectomy (Zweifel and Abel).¹ These statements point to the uterus as the organ which is responsible for the nutrition of the ovaries. Bond believes that the ovarian and uterine secretions are antagonistic, and that the ovaries hypertrophy to a considerable extent after removal of the inhibitory uterine secretion, in cases of hysterectomy. The majority of authors deny both these theories, and it must be admitted that they have not been conclusively proved. Carmichael and Marshall carried out a series of experiments upon hysterectomy in rabbits, and found that the ovaries showed no evidence of change. These experiments were subsequently confirmed by the present author (Fig. 60).

Clinically it has been found that menopausal symptoms consequent upon oöphorectomy are less severe if the uterus or a portion of the uterus is left behind

¹ Zweifel and Abel, *Zeit. f. Gyn.*, 1899.

to act as a channel for the excretion of metabolic products. Such portions must, of course, include the glandular mucosa. In cases of ovarian transplantation Tuffier has found that it is beneficial to the patient to leave a portion of the uterus behind so as to permit of excretion by the uterine tissue. Bond found that retention of uterine secretion had an injurious effect upon the health and nutrition of rabbits, and that it not only prolonged *oestrus* but caused its more frequent recurrence. The retained fluid also interfered with the embedding of the ovum. These observations have not been accepted by other workers. In a series of six similar experiments performed by the author, the animals were well nourished and healthy; and histological examination of the ovary showed no sign of inhibitory influence on the part of the retained uterine secretion.

It is most probable that the ovaries produce substances which are capable of being retained in the uterine mucosa, but it is difficult to ascertain whether this substance persists as such, or whether it is changed by the mucosa into other substances having a different chemical composition and exercising a specific effect upon the organism as a whole. It is difficult also to determine the amount of elimination which takes place by means of the uterine mucosa. The correlation of the ductless glands and the uterine mucosa requires much further investigation. In cases where there are marked metabolic disturbances, such as headache and vomiting, occurring at menstruation, the symptoms as a rule are more manifest in the premenstrual phase or in the very early menstrual phase. This suggests the flooding of the uterine mucosa with chemical substances generated by the ovary, which have a marked toxic effect upon the individual. These symptoms usually disappear as soon as the haemorrhagic discharge becomes established, that is when excretion is taking place. In many instances curettage of the uterus shows the presence of a scanty mucosa. In such cases the question arises, How far is the mucosa itself responsible for the toxic effects by the formation of abnormal substances, or is it merely that there is a failure on the part of this tissue to perform its proper excretory function?

In cases of menorrhagia, more especially those occurring in young girls at the time of puberty, and which may be described as *adolescent menorrhagia*, there is usually a very scanty uterine mucosa. It is most probable, although no actual proof can be brought forward, that such a condition is due to some abnormal chemical processes taking place in the mucosa. The internal secretory organs may be responsible to a certain extent, and there may be a failure in the normal equilibrium between these organs and the uterine mucosa. Such cases cannot be explained alone by congenital defective contractility on the part of the

uterine wall. The administration of hypophyseal extract has a controlling influence upon the menstrual haemorrhage, but this may be due either to an inhibitory property or to its direct action upon uterine contractions. It is evident that the chemical excitability of the uterus is variable, since in experimental injections of various substances, such as ovarian extracts, the reaction of the uterus as manifested by contractions varies considerably. If adrenalin is injected it is found that the effect is much more marked in cases of pregnant and puerperal uteri than of uteri in a quiescent condition. In the virgin uterus contractions are not marked (Cushing). Hypophyseal extract also acts much more upon the puerperal uterus than upon that of the virgin animal. Uterine contractions occur frequently and are rhythmic in character. They are not present before puberty ; and they are in abeyance during the intermenstrual period, although they react to stimuli. Normally they are painless. They are present at the menstrual period and during pregnancy, and are most marked in the puerperal state. In ovarian cystic disease where there is extensive destruction of ovarian tissue, there is frequent loss of function on the part of the uterine mucosa, as is seen by the absence of menstruation.

The function of the uterine *decidua* has been discussed fully by Young. According to this author the decidual development of pregnancy is due to the influence of the chorionic cells. The interstitial cells of the mucosa become the decidual cells. The decidua acts as a barrier against the foetal invasion of the maternal tissues, and also as a storehouse for nutriment, such as glycogen and fat, for the growing ovum. The uterine mucosa in pregnancy shows a perforation of the vessels, with haemorrhagic and oedematous infiltration of the tissues. The decidual enlargement of the interstitial cells prevents the spreading of the oedematous processes which would lead to an opening up of the mucosa by fluid and blood, in parts of the uterus other than those necessary for the embedding of the ovum. The chorionic invasion of the uterine wall is prevented by the decidual cells. It is thought that the ovary controls this decidual reaction, the corpora lutea being chiefly responsible. The placenta takes up the function of and works in conjunction with the corpus luteum and the interstitial cells.

Cases of habitual abortion may be due to chemical changes occurring in the decidua, with the retention of toxic substances of a pathological nature. It is also possible that variations in the constitution of the corpus luteum may account for those cases in which no definite cause can be found for the premature separation of the ovum from the uterine wall. The secretion of the uterus is closely related to that of the endocrinous organs, but more particularly to that of the ovary, as is proved by the changes which take place during reproductive life.

SECTION VII

THE MAMMARY GLANDS

Structure of the Mammae.—The mammae are glands common to both sexes, but it is in the female that marked development occurs, so much so that mammary enlargement is looked upon as normal evidence of the acquirement of the secondary sex-characteristics of the female.

The mamma consists of numerous lobes divided up into lobules by areolar tissue, and containing fat, and convoluted glands. The glands arise from alveoli or larger spaces. The ducts in the lobular portion unite and form the lactiferous ducts. These ducts open on to the nipple by minute ostia. At the junction of the lobular and lactiferous ducts are reservoirs for milk during lactation. The walls of the ducts are rich in vessels; they consist of areolar tissue with non-striated muscle-fibres and stroma. The lining of the ducts consists of columnar epithelium. The nipple is composed of areolar tissue, and unstriated muscular fibres. The papillae on the surface are very sensitive and become erect on stimulation by direct pressure or through the influence of the reproductive organs. The area round the

nipple is called the areola; it contains involuntary muscle-fibres arranged in a circular manner. There is pigmentation of the areola which varies with the individual and with pregnancy. During pregnancy the nipple is longer, more pigmented and erectile. The areola is broader and deeper in colour, and small papillae or elevations are observed. These are the hypertrophied sebaceous glands (Montgomery's tubercles).

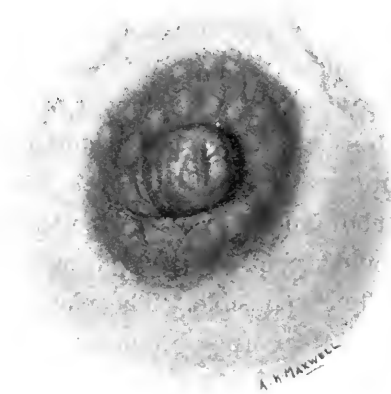


FIG. 61.—Mamma of pregnant woman, showing the areola and dilated venules.

The development and growth of the mammary gland depends to a considerable extent upon the secretion of the ovary. At

puberty when menstruation and ovulation become established, the mammae enlarge, and are therefore a distinguishing feature in the secondary sex-characteristics of the female. Atrophic changes occur after the menopause, and after removal of the ovaries. In cases of maldevelopment of the genital organs there is sometimes an accompanying defective growth in the mammae. Before and during menstruation

some individuals experience a degree of fulness in the breasts, a condition which is also accompanied by pain or tenderness.

Mammary Secretion.—There is some controversy as to the actual mode of milk secretion, and the following theories are held by physiologists: (a) Milk is produced by the breaking loose of the epithelial cells lining the acini, with disintegration of their substance into the alveoli of the gland. This process is analogous to that of sebaceous-gland secretion. (b) The cells secrete substances into the lumen of the alveoli but they themselves are not detached. This is analogous to the process in the submaxillary gland. (c) Some cells discharge their contents, others degenerate; and the daughter nuclei in the centre break away, disintegrate, and leave the basal portion in position. The question is fully discussed by Marshall, and most support is given to the last theory, as it is believed that the cell contents are broken up and pass into solution, forming the carbohydrate and albuminous parts of milk. The fat-droplets in the cells form the milk-fat. The basal portion of the cell remains in position without becoming detached. It subsequently throws out fresh processes which in turn become disintegrated. In contradiction to theory (a) it is urged that no excessive cell proliferation takes place although this would be necessary to make up for the lost cells. In support of the remaining theory no necrobiosis has been observed in the cells, the colostrum containing wandering leucocytes.

Factors which influence Mammary Secretion.—Pregnancy and parturition have the most important influence upon mammary activity, as in the majority of physiological conditions the mammae are in a state of quiescence, as far as secretion is concerned, until pregnancy occurs. In addition to the foetus and its membranes, the ovary has a considerable influence. It is also believed by some authorities that the uterus, internal secretory organs, and the nerve supply have some effect upon mammary secretion. Removal of the ovaries causes atrophy of the mammae in animals, and arrest of development in young animals. If the ovaries are transplanted atrophy is prevented. At puberty the mammae enlarge, and at the menopause atrophy takes place. Defective genital development is frequently accompanied by diminution in the glandular tissue. In some individuals changes occur in the breasts during menstruation, such as enlargement of the gland, and secretion from the nipples. Such cases show a close correlation between the ovarian and mammary functions. The specific substances generated by the ovary having reached the general circulation, exert a special selective action upon the mammae. Aschner and Grigoriu injected extracts of ovaries and obtained milk-secretion as a result. Vincent affirms that these changes are brought about by the action of the corpus luteum. Watson¹ has shown

¹ Watson, *Journ. of Phys.*, 1906.

that the corpus luteum in pregnant rats persists throughout lactation. On the other hand several cases have been recorded of double oöphorectomy during pregnancy, in which milk-secretion occurred normally after parturition. Halban¹ believes that castration has no effect upon lactation. Some authors take the view that the ovary inhibits mammary secretion, owing to the fact that mammary secretion has been known to occur after the menopause and after extirpation of both ovaries. Milk-secretion is sometimes found in pathological conditions associated with tumours of the ovary. In cows, castration during the milking period causes prolongation of the period and also increases the quantity of milk (Marshall). The onset of *oestrus* has a deleterious effect upon the milk-output and its quality. During lactation menstruation is as a rule in abeyance, owing to the inhibitory effect of the mammae upon the ovaries. But there are many instances of menstruation occurring during lactation. Pregnancy may occur during lactation, showing that ovarian function is active. In some instances of menstruation occurring during lactation there is a change in the chemical composition of the milk during the period, as shown by the metabolic changes which take place in the suckling infant, such as sickness and diarrhoea, as if some toxic substances were eliminated by means of the mammae.

There is no evidence that the uterus has an effect upon the growth and secretion of the mammae. In cases of congenital absence of the uterus the mammae may show normal development. Ancel and Bouin² maintain that the muscular wall of the uterus contains a 'myometrial gland' which excites mammary secretion, but this has not been confirmed by others. The mammary changes occurring during extra-uterine pregnancy are due to the presence of the ovum in any situation. Reflex stimulation of the uterus by the mamma is shown by the effect of suckling upon uterine contractions and involution. Mammary changes are due in the most part to the presence of a fertilized ovum, which generates chemical substances. These substances have a specific effect upon numerous organs such as the mammae and internal secretory organs. These substances cause an increase in mammary growth, *but they inhibit secretion*. After parturition, when the foetus and placenta are expelled, lactation becomes established, *i.e.* when the inhibitory agent has been removed. Breast changes are still observed when the embryo has been completely absorbed, as in molar pregnancy, and it is therefore most probable that the generating substance is in the extra embryonic structures of the ovum. If the ovum dies during pregnancy milk-secretion sometimes persists in the breasts of the mother. The fertilized ovum therefore promotes hyperplasia of the mammary glands, and when

¹ Halban, *Zeit. f. Gyn.*, 1901.

² Ancel and Bouin, *Compt. Rend. Soc. de Biol.*, 1908; *Journ. de Phys. et Path. Gén.*, 1910.

this influence is withdrawn by parturition, the secretory function is permitted to proceed.

How far the internal secretory organs affect the secretion from the mammae is unknown. Hypophyseal extract causes a contraction of the glandular tissue, and a consequent temporary increase in the milk-output, but it has not been proved that there is any increase in mammary secretion as a whole. The influence of the other organs is unknown.

Mammary function is independent of central nerve influences. Cases of paraplegia have been recorded where lactation was normal after parturition. Experimental section of the cord has shown that milk-secretion may then proceed without any interference. Direct nerve-excitation of the nipple by suckling or manipulation may stimulate the secretion even in virgins or males. If suckling during lactation is suspended the milk supply soon decreases and finally dries up completely. In dairy-farms the supply of milk depends to a considerable extent upon the efficiency of the milker. Psychical disturbances, such as emotion and shock, have an effect upon the mammary secretion, but this may act indirectly through the internal secretory organs. Although the nerve supply is not necessary for mammary function, we must admit that there is a correlation between the genital organs and the mammae by means of the sympathetic system which cannot be explained by the action of merely chemical agents through the blood stream. Drugs, diet, exercise, etc., influence mammary secretion to a certain extent. The occasional secretion of milk in the new-born is still unexplained. It may be classified with those instances of menstrual discharges in the new-born which are explained as being disturbances in the economy of the internal secretory organs as they become adjusted to the new conditions of post-natal life.

SECTION VIII

CORRELATION OF THE INTERNAL SECRETORY ORGANS WITH THE FUNCTION OF REPRODUCTION

It is difficult to consider any vital function without taking into account the important part played by the whole endocrinous system. In any description of the factors which are concerned with the function of reproduction, due consideration must be given to the harmony or disharmony of the whole reproductive function, which is closely bound up with that of the internal secretory organs or ductless glands as they may be called. It is impossible in the light of recent researches to isolate one particular organ, such as the ovary, and say that it is solely responsible

for the maintenance of certain physiological functions. The whole endocrinous system is so finely balanced that the increase or withdrawal of secretion on the part of one organ may upset the physiological equilibrium of all the others, until readjustment of function is capable of being established.

During the last twenty years the literature upon the ductless glands has become flooded with inaccurate and unreliable statements, and we have now reached the stage when it is almost impossible to arrive at any very definite conclusions as to the physiological functions of these organs, in our bewildered efforts to separate the true from the false.

The dual functions of many of these organs, and the co-operation of one particular organ with another, are to a great extent responsible for the varied results which are found in experimental research. The withdrawal of the secretion of one organ may mean not only that the individual is deprived of that secretion, but that the secretion from some other organ is now acting without control. The phenomena manifest after extirpation of an organ may therefore be partly due to excess of secretion on the part of another organ. We are still in doubt as to the inter-relationship of these ductless glands, and as to when they stimulate and when they control. From our study of the development of the early gonad-cells we are forced to conclude that these cells should be classified by themselves, and that they differ from the cells of the soma. And yet from observations upon the endocrinous system it is held that all the organs comprising it are capable of interchange of function, with the exception of the actual reproductive cell itself—the ovum or spermium. Noël Paton believes that the connecting link between the soma and gametes is to be found in the interstitial cells in both sexes. Further research upon the functions of these cells may lead to the opinion that they are the essential factors in the maintenance of the genital functions. The chief organs of internal secretion which are closely associated with the function of reproduction are the thyroid, hypophysis, adrenals, parathyroids, and thymus. The pineal gland is also to be included, but our knowledge of its function is very imperfect.

The Thyroid.—The thyroid gland is closely associated with the physiological function of the reproductive organs. Our information is obtained, not only from observations upon laboratory experiments, but from clinical experience. Both methods of research are beset with certain difficulties in making accurate scientific deductions. In the case of loss of an organ by operative measures, the results obtained may be due to alterations in the whole metabolism from an interference with the endocrinous equilibrium, and reactions may manifest themselves which would not appear under different conditions. For example, removal of an internal

secretory organ may give certain results in one species of animal, and entirely opposite results in another. Again, animals under abnormal metabolic conditions, such as confinement, malnutrition, pregnancy, etc., vary greatly in their reactions. The results of clinical experience must to a certain extent differ from those of laboratory workers, not only since the species of animal is different, but largely because due consideration must be given to the existing pathological condition which must affect the organism as a whole. We cannot as yet estimate the influence of tumour-growths upon metabolism. From a study of clinical symptoms merely, it is impossible to do more than generalize upon the probable physiological function of the internal secretory organs. The collaboration of the laboratory worker with the clinician, and investigation by means of accurate chemical research, will do much to clear up the whole question of the functions of the ductless glands.

The thyroid enlarges at puberty, during the premenstrual phase, and during pregnancy. In conjunction with the hypophysis, therefore, it has a marked relationship to reproductive function. The thyroid is more active in the female than in the male, as it is more prone to pathological affections, particularly during reproductive life. According to Hertoghe¹ it has an inhibitory influence upon menstrual activity. Menstruation is normal if the thyroid is physiologically active; if it is inefficient there is an excessive activity on the part of the uterine mucosa which leads to profuse haemorrhagic discharge. It is not clear, however, whether this is due to the uncontrolled secretion from the ovary. It may account to some extent for the condition of adolescent menorrhagia. It is said that if there is deficiency in the thyroid secretion, menstruation may be delayed at puberty, but this is probably due to deficient function on the part of the ovary as well.

Hertoghe states that thyroid hypertrophy takes place in pregnancy, and that it is the unusual amount of thyroid secretion in the blood which inhibits menstruation, thereby protecting the ovum from menstrual activity. The use of thyroid extract should therefore counteract the tendency to habitual abortion, and also control excessive menstrual haemorrhage. Thyroid secretion accelerates uterine involution, and promotes lactation. Ovarian insufficiency causes activity of the other ductless glands, and this is especially the case with the thyroid. After oöphorectomy there is enlargement of the thyroid, a fact which has been proved experimentally as well as clinically. Goitre has been known to develop in women after the ovaries have been removed; and enlargement has been observed in cases where ovarian tissue is physiologically inactive, owing to cystic degenerative changes having taken place. After removal of the thyroid the uterus may become atrophic, even in cases

¹ Hertoghe, *Amer. Med.*, 1914.

in which the ovarian activity remains normal, or becomes increased. Hypersecretion on the part of the thyroid may be accompanied by amenorrhoea and sterility, as is evidenced in cases of goitre. If X-rays be applied to the thyroid in such cases menstruation may become re-established. Ovulation may be stimulated by the administration of thyroid extract, fertilization having resulted in some cases of sterility. Amenorrhoea and sterility are found frequently in cases of myxoedema.

The influence of the interstitial ovarian cells upon the thyroid is said by Thompson¹ to be greater than that of the corpus luteum. The thyroid and hypophyseal secretions, together with those of the ovary, are concerned with the manifestations of puberty. How far the foetal thyroid reacts upon the internal organism is unknown, but that there is some influence is most probable. The action of the maternal thyroid may in conjunction with the foetal thyroid prevent the retention of katabolic products during pregnancy. It is said that in excessive toxaemic conditions occurring during pregnancy there is thyroid deficiency. Clinically, in some cases of toxæmia during pregnancy the administration of thyroid extract has had beneficial results. The thyroid influence on metabolism is undoubtedly great. In diminished secretion there is a tendency to the deposit of fat. Calcium-excretion is controlled to a considerable extent by the thyroid, but it is difficult to give any accurate statement as to the amount of influence possessed by this gland, since the hypophysis, ovary, and parathyroids also are involved.

The Hypophysis.—An enormous amount of work has been done during the last few years upon the physiological function of the hypophysis and its relationship to genital function. The work of Blair Bell in regard to the action of the hypophyseal-gland extract upon the uterus is now well known. Marked contractions take place in the wall of the uterus under the influence of hypophyseal extract, and these are more evident in the puerperal uterus than in the virginal organ. The thyroid and gonads are closely related to the hypophysis, but the precise nature of this relationship has not as yet been accurately determined. Castration causes enlargement of the hypophysis, and increase in size has been observed to take place during pregnancy. Removal of the gland causes uterine atrophy (Aschner, Cushing). Deposit of fat has also been observed after removal. In the case of excessive secretion in the adult there is amenorrhoea and sterility. In the case of an infant, however, or before puberty, there is defective development of the genital organs, such as is met with in examples of gigantism. It is said that deficiency in the hypophyseal secretion may cause an increase in menstrual haemorrhage. In acromegaly, where the secretion is excessive in amount, and where ovarian function also is deficient, there is a tendency

¹ Thompson, *Surg. Gyn. and Obst.*, 1913.

for the individual to lose the more marked feminine characteristics. Hypophyseal secretion is also intimately related to the calcium metabolism, and is said to favour the excretion of these salts.

The Adrenals.—The adrenal cortex is closely associated with the physiology of the gonads, both in function and in histological structure. There is enlargement of the adrenals in animals in the breeding season, and during pregnancy. Removal of the adrenals causes atrophy of the uterus, but pregnancy is not found to be interrupted (Novak).¹ Seitz² believes that the adrenals are essential for fertilization and pregnancy. In cases of excessive adrenal secretion there is amenorrhoea and sterility, and the secondary sexual characteristics become modified, the tendency being a nearer approach to those of the male. This is illustrated in cases of hypernephromata in girls (Glynn). In Addison's disease the amenorrhoea is probably due to uterine atrophy, but it is uncertain how this disease affects the ovaries themselves. There is a close correlation between the structure of the adrenal cortex and the luteal cells. Evidence of seasonal and functional changes having taken place has been found in specimens of adrenals examined histologically. The adrenals cause retention of the calcium salts and therefore act in opposition to the thyroid. Experiments upon removal of the adrenals must be performed with great accuracy, as it may happen that portions of adrenal tissue occur in other sites as well as the normal. In the human female portions of adrenal tissue have been found in the upper wall of the vagina. According to Seitz sugar-metabolism is stimulated by the secretion from the thyroid, hypophysis, and adrenals. The pancreas, parathyroids, and ovary have a tendency to diminish sugar-metabolism. Stolper³ believes that ovarian secretion increases sugar-metabolism, since the latter is reduced in castrated animals. In women before the onset of the menstrual period, it has been observed that there is sometimes an increased desire for sugar. This may have some relationship to the glycogenic function of the uterine mucosa.

The Parathyroids.—The activity of the parathyroids in pregnancy is open to doubt. It is stated that in animals which have been subjected to partial removal of the parathyroids, the thyroid may develop during pregnancy or lactation (Morell Frouin). Werelins⁴ found that pregnant dogs after thyro-parathyroidectomy died sooner than non-pregnant animals after the same operation.

The Thymus.—At puberty there are regressive changes in the thymus, and these have been explained in various ways. One theory is that the activity of the gonads has an inhibitory influence upon the thymus, causing atrophy to take place. Experiments

¹ Novak, *Arch. f. Gyn.*, 1913.

³ Stolper, *Gynäk. Rundschau*, 1913.

² Seitz, *Deut. Gesellsch. f. Gyn. Halle*, 1913.

⁴ Werelins, *Surg. Gyn. and Obst.*, 1913.

upon castration result in persistence of the thymus. It is generally believed, however, that the thymus and gonads are not antagonistic in their actions, but that the reproductive glands at puberty take over the function of the thymus. It has been stated that the thymus causes calcium retention and therefore helps to build up the skeleton; but on the other hand calcium is required for the reproductive functions. There may be a relationship therefore between the adrenals and the thymus. It is believed that the thymus may prevent sex-precocity. Noël Paton has found that removal of the thymus causes hypertrophy of the testes. It is difficult to determine with any degree of accuracy the function of the thymus in its relation to the gonads. The solution lies in the answer to the questions—Do the gonads develop because of withdrawal of the thymus secretion? or, Does the thymus regress because of the development of the gonads? Persistence of the thymus may be accompanied by amenorrhoea and defective development of the genital organs.

The Pineal.—The physiological function of the pineal gland is little known. Aschner believes that it is enlarged during pregnancy. Atrophy is said to take place after oöphorectomy. In tumours of this organ, sex-precocity is sometimes found together with early ossification of the cartilages of the long bones. The subjects of such tumours may show a considerable deposit of fat.

The question of the determination of the special functions of the internal secretions is a difficult one. In pregnancy there is even a greater degree of difficulty owing to the complicated secretory function of the placenta. We have not as yet estimated with any degree of accuracy the function of the placenta in its relationship, not only to the embryo but to the maternal organism itself. It is possible that the placenta to a certain extent takes on the functions of the endocrinous organs.

TYPES OF MICRO-ORGANISMS MET WITH IN THE FEMALE GENITO-URINARY TRACT

By ERNEST H. SHAW, M.R.C.P.
(London)

A LARGE variety of organisms occur in the female genital tract, and a lesser number in the urinary organs. All the bacteria found in the urinary tract are also found in the genital apparatus, but many organisms met with in the latter are not found in the urinary organs.

VAGINAL FLORA IN THE NEW-BORN CHILD

From the observations made by various workers it appears that micro-organisms make their appearance at a very early stage of life. Vahle¹ concludes that for the first twenty-four hours the vagina is sterile, but by the third day it always contains micro-organisms; these include *staphylococcus pyogenes albus* and *aureus*, and streptococci. Stroganoff² found that in some cases bacteria were present in the vagina a few hours after birth, and in a certain proportion of cases inoculation occurs *in utero* or during birth, especially in breech presentations. He found a great variety of micro-organisms, including streptococci, staphylococci, diplococci, etc.

Schmidgall³ investigated 21 infants and 10 children in the first year. The vaginal secretion was placed on Schotmüller's blood-agar plates. It was proved that germs enter the vaginal tract during the first days of life. From the second day onwards there was an increase in the number of planted colonies. Most often streptococci, staphylococci, *b. coli communis*, and *b. vaginae* were found; occasionally Gram-negative coliform bacilli, *micrococcus tetragonus*, *saccharomyces*, anaerobic streptococci, staphylococci, *bacillus haemophilus*, and *bacillus bifidus*. The bacteria did

¹ Vahle, *Zeitschr. f. Geb. und Gyn.* Bd. xxxii. H. 3, v.

² Stroganoff, *Monatschr. f. Geb. und Gyn.* Bd. ii. p. 381.

³ Schmidgall, *Beit. z. Geb. und Gyn.* Bd. xix. s. 190, 1914.

not grow well. During this observation haemolysis was obtained and lost, and appeared as a variable or changing ferment-peculiarity of the bacteria. He remarks that the character of the vaginal secretion is probably influenced by the flora of the mother. Bowel bacteria appear in the first nine days of life, and form about half the germs present in older children. The investigation is, in its results, negative to the existence of a natural, vaginal, antiseptic function.

FLORA OF THE ADULT VAGINA

The investigations made by many observers have revealed a great variety of organisms present in the adult vagina; the published results differ, however, in many cases. The earlier work carried on by Housmann, Gönner, Bumm, Winter, and Steffek was followed by Döderlein's monograph in 1892. Gönner in 1887 found many varieties of micro-organisms, including bacilli which were very difficult to cultivate. The cocci present, which were cultivated with ease, he found to be non-pathogenic. He concluded that the vaginal secretion contains no pathogenic bacteria. Bumm also failed to find any pathogenic germs. Winter believed that pathogenic germs were present in the vagina in a state of lessened virulence.

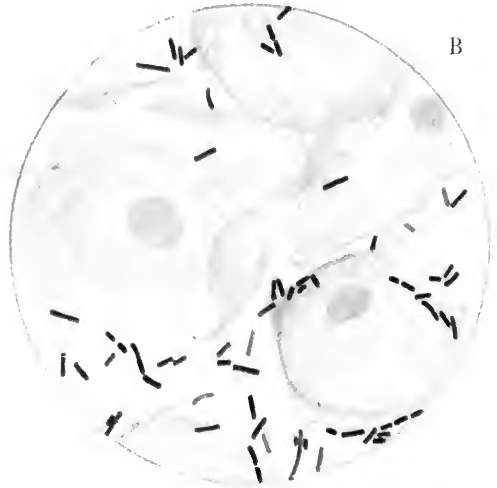
Döderlein¹ examined the vaginal secretion of 195 pregnant women; he divided the cases into normal and abnormal secretions, on the macroscopic evidence and their reactions. Then bacteriological examinations were made, and the flora found to be quite different in the two conditions. In rather more than half the cases the secretion was normal in character, *i.e.* whitish in colour like curdled milk and containing no mucus, the reaction being intensely acid. Microscopically there were found epithelial cells and mucus bodies moistened with lymph from the vaginal mucous membrane. On cultivation was found a bacillus with distinctive and characteristic qualities. It is a long, thick bacillus, non-motile, anaerobic, and produces lactic acid (Plate I. *a* and *b*). It was accompanied by a yeast fungus in 36 per cent of the normal cases; this fungus Döderlein believed to be identical with *monilia candida bonorden*. The bacillus is antagonistic to staphylococci, and has the power of destroying them within certain limits. Experiments were performed by introducing staphylococci from living cultures into the virgin vagina. It was found that the staphylococci had disappeared in four days. Döderlein attributes the germicidal action of the vaginal contents to the acid produced by the vaginal bacillus. In support of this he gives the following facts: (1) All pathological secretions, containing saprophytes and many pathogenic germs, are weakly acid or alkaline in reaction. (2) In puerperae the vaginal

¹ Döderlein, *Das Scheidensekret und seine Bedeutung f. das Puerperalfieber*. Leipzig, 1892.

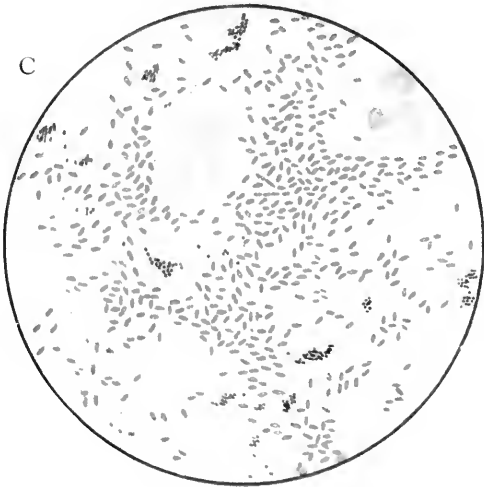
PLATE I. Vol. I



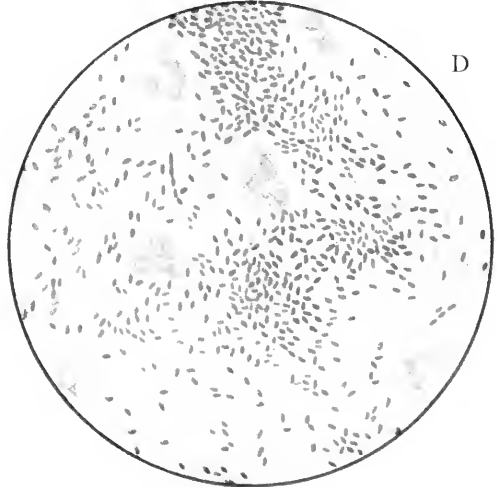
A. Film made from vaginal discharge and stained with Löffler's methylene blue. Note squamous cells and vaginal bacilli on and between them.



B. The same discharge stained by Gram's method and a counter-stain of weak carbol-fuchsin. The bacilli are Gram-positive.



C. Film of vaginal discharge stained with Löffler's methylene blue. Note the large number of bacilli (B.C.C.) and numerous cocci (staphylococci). Several pus cells are seen faintly stained.



D. The same discharge stained by Gram's method and counter-stained with weak carbol-fuchsin. Only the Gram-negative bacilli are shown.

bacillus disappears and its place is taken by many kinds of saprophytes; the lochial discharge is alkaline. (3) When the lochia cease the saprophytes disappear, the vaginal bacillus reappears, and the vaginal secretion becomes intensely acid.

The abnormal secretions were described as being yellowish or greenish in colour, of the consistency of cream, mixed with mucus, and often containing bubbles of gas; the reaction either weakly acid or alkaline. It is usually secreted in large quantities, and on cultivation contains the greatest variety of cocci and bacilli. Of the 195 cases 8 only showed streptococci, and these were virulent in character in 5 cases.

The above views of Döderlein have not been universally accepted, but they are considered correct in the main. Other investigations carried out by Burgubru, Williams, Stroganoff, and Burkardt revealed the presence of streptococci in 1 out of 12, 3 out of 15, 2 out of 9, and 5 out of 16 cases, respectively.

Krönig¹ made 200 examinations of the vaginal secretion of pregnant women, and found that, apart from gonococci and thrush fungus, they contained no pathogenic germs. He inoculated the vagina with pure cultures of streptococci, staphylococci, and *bacillus pyocyaneus*, and found that there were none left after eleven to twenty hours. This observer further found that if a lysol douche were given an hour before inoculation of the vagina with these organisms it took nineteen to thirty-six hours for the vaginal secretion to destroy them. He states that acid, neutral, and alkaline secretions all have germicidal powers.

Menge² confirmed these results in the course of a study of the germicidal power of the vaginal secretions in non-pregnant women, except, however, that he rarely found streptococci. He came to the conclusion that the following were the causes of the germicidal power of vaginal secretions, placing them in the order of their importance: (1) the antagonism of the normal flora of the vagina; (2) the products of the life process of the vaginal bacilli; (3) acidity of the secretions; (4) the germicidal power of the anatomical elements of the vagina; (5) the leucocytosis produced either by the vaginal discharge or the infecting organisms; (6) phagocytosis following the leucocytosis, and the absence of free oxygen in the vagina.

Walthard³ examined the vaginal secretions of 100 women *ante et post partum*, and formulated the conclusion that the genital canal may be divided practically into two parts, one infected and the other sterile. The former includes the vestibule, vagina, and lower part of the cervical canal; the latter the upper part of the cervical canal, the uterine cavity, and the tubal canals. The causes of this division of the canal are: (1) the plug of mucus which lies in the cervical canal and which, owing to its poorness

¹ Krönig, *Deutsche med. Wochenschr.*, 1894, p. 819.

² Menge, *Arch. für Gyn.* vol. xlviii. p. 201.

³ Walthard, *Deutsche med. Wochenschr.*, 1894, p. 819.

in albuminoids furnishes no nutriment for micro-organisms ; (2) the leucocytes which are found in great numbers at the level of the external os.

According to Walthard, three divisions of the genital canal should be recognized : one, the lower, containing leucocytes and bacteria ; the next containing only leucocytes ; and the third, the upper, containing neither leucocytes nor bacteria. Walthard found both during pregnancy and after delivery streptococci, staphylococci, gonococci, and the colon bacilli. Streptococci were found in 27 cases out of the 100 women examined. Inoculation of normal tissues of animals by these streptococci produced no results, but if the tissues were reduced in vitality, or the animal's system lowered in any way, the inoculation of these streptococci produced abscesses in which the organisms rapidly regained all their original virulence. From his experiments and observations Walthard concludes that the vaginal streptococci are not virulent and behave only as saprophytes upon healthy tissues, but if the tissues are injured in any way the streptococci can become infectious and attain a virulence quite equal to that of the streptococci of puerperal infection.

Stroganoff obtained results from the examination of 11 pregnant women, which led him to confirm Döderlein's assertion that the vaginal bacillus produces lactic acid, and states that the vaginal secretions of the newly-born are weakly acid, and become more and more acid as bacteria develop in the vagina. He quotes experiments by Schlutter showing that staphylococci do not grow so well in an acid medium, and that the latter destroys the streptococci of erysipelas. He also shows by experiment that the vaginal bacillus produces not only acid in culture media, but also other products of its life-processes which retard or prevent the growth of staphylococci. Stroganoff accounts for the sterility of the upper cervical canal and the uterine cavity in all women, non-pregnant, pregnant, and puerperal, by : (1) the active germicidal properties possessed by the cervical mucus ; (2) the mechanical flow of menstrual blood, descending placenta and membranes during labour, and the outflow of the lochial discharges ; (3) the germicidal action of the blood itself.

Stroganoff comes to the following conclusions as a result of his study : micro-organisms are found in the vagina of all pregnant women ; usually the vaginal bacillus in normal cases is the most plentiful, but there are also other forms present in addition. A pathological condition of the mucous membrane alters the normal flora. The vaginal secretion in pregnant women is strongly acid in reaction. In addition to the micro-organisms, one usually sees epithelial cells and a few white corpuscles. The cervix in the majority of normal cases contains no micro-organisms, and when present they are few in number. The reaction of the cervical secretion is alkaline.

No hard-and-fast line of demarcation between a normal and a pathological

vaginal secretion can, however, be made. Taking first a case in which the discharge is slight, and of a clear mucoid character, one finds under the microscope epithelial cells and a large number of vaginal bacilli, occasionally a few cocci (Plate I. *c, d*). On cultivation the former organism and perhaps a few staphylococci appear. Then take a case in which there is a plentiful discharge of whitish pus-like material. Under the microscope the organisms are present in enormous numbers, Gram-negative and Gram-positive bacilli and cocci, practically an emulsion of bacteria. Pus cells may be absent altogether in spite of the abundant bacterial growth in the vagina; on the other hand they may be present in large numbers. In another type of case of recent origin one looks for and finds numbers of gonococci appearing as Gram-negative diplococci resting, in large numbers, in the substance of the pus-cells and also scattered about between the cells. Finally, there is the occasional case of discharge from a neighbouring abscess bursting into the vagina, in which the offending organism is usually the colon bacillus. Other causes of vaginal discharge, such as new growths of the cervix or body of the uterus, specific ulceration, etc., are infected with the usual medley of micro-organisms.

The accompanying drawings illustrate the various pictures presented under the microscope (Plate I. *a, b, c, d*).

BACTERIOLOGY OF PUERPERAL INFECTION

The types of micro-organisms found in the uterus in this disease are rather numerous, but in the great majority of cases only one or two of these varieties are found. The most common organism by far is the streptococcus, often occurring alone, but in many cases occurring in company with other types, such as the *staphylococcus albus*, pseudo-diphtheria bacilli, or *bacillus coli communis*. Much work has been done by investigators of the bacteriology of the uterus in puerperal infection, and the results, although differing in certain details, on the whole tend to support the statement that streptococci are the most common offenders. Not much information is at hand showing the proportion of cases in which micro-organisms have been found in the blood stream during life, and the writer proposes to illustrate this point from his own work. The invariable routine method in cases of puerperal infection should be: (i.) to examine stained films, and make cultivations, of the uterine discharge, (ii.) draw off blood from a vein and inoculate culture media, and (iii.) make an absolute and differential count of the white blood-cells. The smears are stained by Gram's method, and on examining them under the oil-immersion lens one can often form a very good idea as to the precise organism which is present or which predominates; for instance, Gram-positive cocci in chains indicate some form of streptococcus,

Gram-negative bacilli make it appear very probable that *b. coli* are present, and so on. The inoculated tubes, wide-bore agar-tubes, or petri-dishes will show colonies growing on the surface after about twelve hours. In most cases the colonies are very small and pale, indicating streptococci; the culture is often pure, but in many cases larger white colonies are also present in varying number, and these are usually staphylococci. Occasionally other organisms are found either mixed with the above or occurring as a pure culture. Broth cultures are not of much use, for in the case of a mixed growth one cannot determine the relative numbers of each organism. On the surface of a solid medium, such as agar, the exact proportions are readily seen, and subcultures can be made of each organism separately. If a vaccine is deemed advisable it can thus be made from one or more of these cultures in exact proportions.

The blood from a vein is placed in three broth-tubes, and on one or two agar-slopes; these are placed in the incubator and looked at from time to time. If organisms are present in the blood they will multiply, and colonies will appear as small white dots entangled in the fibrinous clot in the broth-tubes, or on the surface of the agar-slope. Motile organisms like *b. coli* or *b. typhosus* cause a uniform turbidity in the broth-tube. The growth generally becomes visible in about twenty-four to forty-eight hours, but sometimes it is delayed for three to four days. The proportion of cases in which organisms have been found in the blood is not large, and is, roughly speaking, about 5 per cent. The writer has found that it is not possible to diagnose septicaemia on clinical evidence alone with any degree of certainty, for many patients have been examined who appeared to be suffering from a blood-infection, and yet on cultivation of the blood no organisms were found. Other cases which did not look so urgent were found on cultivating the blood to be infected. As a broad general guide, the absence of bacteria in the blood on cultivation indicates a good prognosis, and their presence in the blood the reverse. Exceptions, however, occur in both directions, for now and then a patient with apparently sterile blood gradually loses ground and dies, and another patient with organisms in her blood gradually improves and finally recovers. Post-mortem examinations in some of the first-named cases reveal pockets and tracts of pus in the uterus, broad ligaments, and retroperitoneal connective tissues, with also suppurative lesions of the uterine veins.¹ In some such cases organisms have been found in the blood at a second examination made just before death, or in blood drawn from the heart at the post-mortem.

The type of streptococcus found has proved to be the *streptococcus brevis* in the great majority of cases, the chains usually consisting of three to six cocci. *Streptococcus longus* is met with in a few cases.

¹ The Pathology of Uterine Infection is fully discussed in a later Article (see p. 526).—EDITORS.

The *mode of infection* is always a source of worry to the person concerned in the confinement, and outside contamination can be excluded with certainty in many cases. In these instances no digital examination has been made by the medical attendant before delivery, and in some cases birth has taken place before his arrival. The conclusion appears to be warranted that the infection in many patients is due to streptococci, or other bacteria, living in the vagina and cervix, for these organisms are present in the vagina and cervix of a certain proportion of cases during pregnancy. This is beyond dispute and has been proved by the observations of Burgubru, Williams, and others quoted previously. An open path for infection is formed after parturition by separation of the placenta from the uterus, and in the occurrence of tears in the cervix, vagina, or perineum. The organisms inoculated into these open surfaces or wounds are no doubt destroyed in the great majority of cases by the protective powers of the human tissues; but in some cases they thrive and multiply, perhaps only slightly and for a short time, while in others they multiply more rapidly owing perhaps to a larger dose, or to high virulence on the part of the germ, or to lessened resistance on the part of the patient. This last factor is undoubtedly the chief one.

Foulerton and Bonney¹ have contributed a valuable article based on the bacteriological examination of 54 cases of this disease. In the 54 cases examined the uterus was found to be sterile in 15. The cases were divided into 40 *severe* and 14 *slight*. Bacteria were found in the uterus in 35 of the former group and 4 of the latter. Streptococci were found in 25 of the 35 severe cases: in 10 of them the culture was pure, and in 15 they were present in company with other organisms. Taking all the cases together, Foulerton and Bonney found *streptococci* present in 46·2 per cent, but excluding the sterile cases the percentage in infected uteri was found to be 64·1.

The authors quote results given by other observers which are well worth repeating here :

	Number of Cases examined.	Streptococci found in
Czerniewski	91	49 or 53·8 per cent.
Krönig	179	75 or 41·9 „
Whitridge Williams	150	44 or 29·4 „
Vogel	24	7 or 29·1 „
	444	175 or 39·4 „

¹ Foulerton and Bonney, *Practitioner*, 1905, vol. lxxiv. p. 387.

From the above figures it will be seen what an important part the streptococci play in puerperal infection.

The question of the specific identity of the various strains of streptococci is important in relation to the line of treatment by antitoxins in serum. As yet there is no specific serum which can be used with certainty in cases of puerperal fever. First there are different strains of streptococci; the group is a large one and from it several forms have been provisionally separated and tabulated according to morphology and cultural reactions, but this leaves a large surplus of streptococci which do not conform to these tests. An antitoxic serum made from a number of different strains (*polyvalent serum*) may be used as a routine means of treatment. It is of value in many cases and useless in others. This is probably due to the facts mentioned above. If the particular case is infected with streptococci which are included in the polyvalent serum there is a chance that much good will result; if not then we may account for failure by their absence. But in spite of all this uncertainty it is well worth while injecting serum at once in every case and, unless the presence of streptococci is negatived by the bacteriological findings, continuing the injections.

Other organisms than streptococci are sometimes found to be the prime factors in the causation of the disease. Foulerton and Bonney found that pneumococci were present in pure culture in one case; in three others they were accompanied by other organisms, whilst in yet two other cases a diplococcus was found which was probably of the same nature, although definite proof was not demonstrated by animal experiment. The continuance of injections of anti-streptococcal serum would clearly be of no use in these cases.

Staphylococcus pyogenes aureus is a very uncommon cause of puerperal fever, and the authors quoted above found it only once in their series of cases. Others, including the present writer, have had the same experience.

Staphylococcus pyogenes albus frequently occurs as a secondary infecting organism, complicating more severe primary infection by streptococci and other bacteria. Foulerton and Bonney found it pure in one case of slight degree. The virulence of this organism is slight in the great majority of cases, but its powers of increased virulence may be seen in cases of septicaemia of other regions.

A *Diphtheroid bacillus* was found in two cases by the above authors; both cases were severe. The bacillus resembles the true diphtheria-bacillus very closely, and is a very common inhabitant of the non-pregnant cervix. The writer has also found it in the contents of a suppurating Fallopian tube. Its frequency in the later stages of gonorrhoea is referred to in the chapter under that heading.¹

¹ Article on Gonorrhoeal Infection in Women (p. 567).

Bacillus diphtheriae.—Cases have frequently been recorded of puerperal infection by this organism, but the experimental proof of the exact nature of the organism is wanting in most cases. In a few cases this proof has been obtained, but it is a rare infection. Haultain records a definite case in which the patient recovered after the injection of anti-diphtheritic serum. Considering the frequency with which pseudo-diphtheria bacilli are found in the cervix, and the difficulty of separating one from the other on morphological grounds, definite bacteriological proof must always be sought.

Bacillus coli communis.—A few cases of primary infection by this organism have been recorded, but they are distinctly rare. The cases have not been very severe in character. The writer has recently met with a case, however, in which *b. coli* was found in the blood during life, and the patient died with a pure infection by this organism. It is probably the most frequent cause of secondary infection.

Micrococcus gonorrhoeae.—Foulerton and Bonney did not meet with a single case of puerperal fever due to this organism. Other authors have met with such cases in varying numbers. Krönig for instance gives 27.9 per cent of his cases as due to this organism. Whitridge Williams found gonorrhoeal infection in but 5.4 per cent of his 150 cases. Foulerton and Bonney had 6 cases in which this organism may have been overlooked, but in which there was other and sufficient cause for the symptoms observed. They are of opinion that Williams' figures more nearly represent the numerical importance of *m. gonorrhoeae* as a cause of puerperal infection.

Foulerton and Bonney found an unnamed Gram-negative diplococcus in two of their cases; one was fatal and the other, of mild type, recovered. The diplococcus grew well on gelatine without liquefying the medium, and also on all the ordinary laboratory media. The growth was more active at 37° C. than at 22° C. It was readily decolorized when stained by Gram's method. Its pathogenicity in the two cases is open to doubt, but they point out that the same species of diplococcus has been found in the secretion of chronic cervical catarrh in non-pregnant women. Its resemblance microscopically to *m. gonorrhoeae* is also noted, and its confusion with this organism in the writings of earlier authors is mentioned.

Bacillus pyocyaneus was found in 2 cases, the first in combination with streptococci and the second in a case in which *bacillus coli communis* was present.

Anaerobic Bacteria.—Several species have been found at various times by different authors, including *b. tetani*, *b. oedematis maligni*, and *b. aerogenes capsulatus*, but on the whole it seems doubtful whether puerperal infection ever owes its origin primarily to any one of the organisms. Foulerton and Bonney found an anaerobic bacillus in only one case, and this appeared to be secondary to

streptococci. Krönig found anaerobic bacteria in 32 out of 179 cases of puerperal endometritis. Kuehn recorded a case in which a woman died with symptoms of tetanus, and after death streptococci, *b. tetani*, and *b. coli communis* were cultivated from the uterus. He also had a case in which a general emphysematous condition of the organs and tissues came on within six hours after death following a criminal abortion, and he found a bacillus which was believed to be *b. oedematis maligni* together with other organisms in the uterus and other organs of the body.

B. aerogenes capsulatus has been found in the uterus in a number of cases in which an emphysematous condition has developed in the tissues and solid organs of the body. These gas-forming organisms have no doubt escaped into the blood stream during the last hours of life, and rapidly multiply immediately after death.

The bacteria of the incompletely described group *proteus bacillus* have been recorded as being the primary cause of puerperal infection, but the evidence is not definite.

Dobbin recorded a case of infection by *b. typhosus*, but the evidence pointed to a primary general infection in which labour supervened.

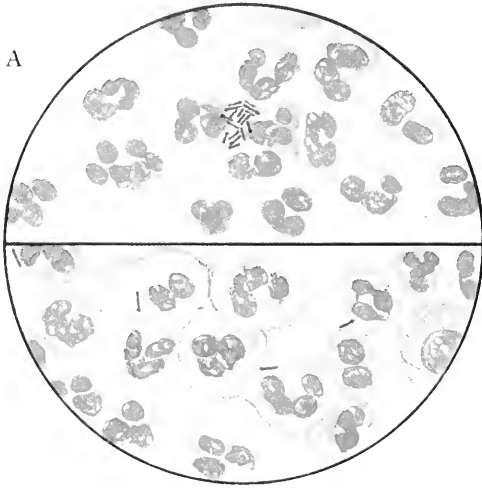
BACTERIOLOGICAL EXAMINATION OF THE URINARY TRACT

The bacteria found in this region are not very numerous in variety, and in the great majority of cases they are limited to the *b. coli* type. Careful attention must be paid to the method of collecting urine for cultivation of organisms, and the specimens must be drawn off by means of a catheter to be of use for exact diagnosis.

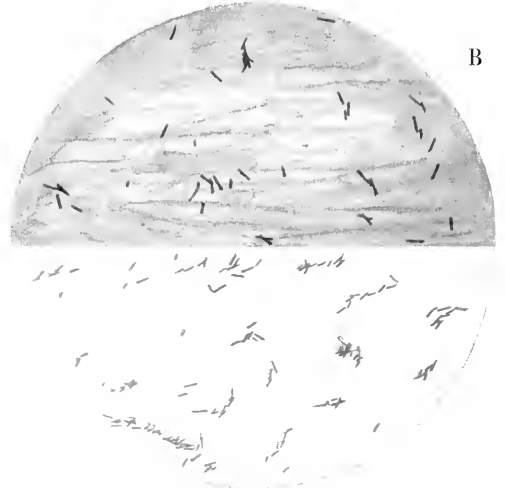
Let us take a case from the beginning. A specimen passed naturally is examined and reveals the presence of pus under the microscope. A stained film and cultivation from this specimen will almost certainly show some kind of micro-organism; it may be *b. coli* or staphylococci or a mixture of these, with perhaps other bacteria in addition (Plate II. c.). Pus in the urine may come from the vagina during the act of micturition and does not prove that pyuria is present. In cases with clinical symptoms and signs pointing to cystitis or pyelitis, large quantities of pus and swarms of motile bacilli in the urine on more than one occasion may be taken as pretty good evidence of true pyuria. In all cases, however, a catheter specimen is to be preferred. It is needless to add that strict aseptic precautions with the instrument and urethral orifice must be observed. This ensures safety for the patient in that no external organisms are introduced into the bladder, and it gives the pathologist an uncontaminated specimen for investigation.

B. coli communis is the most common organism met with in pyuria; in the

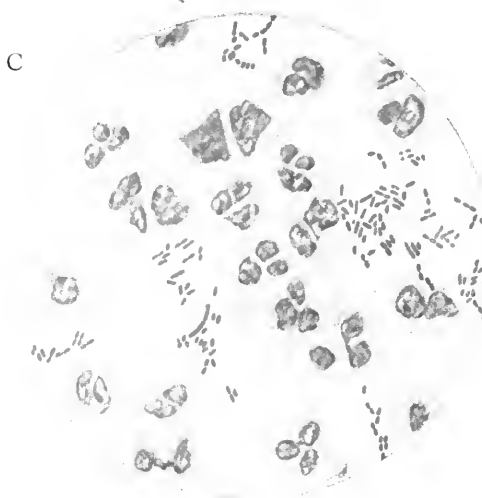
PLATE II. Vol. I



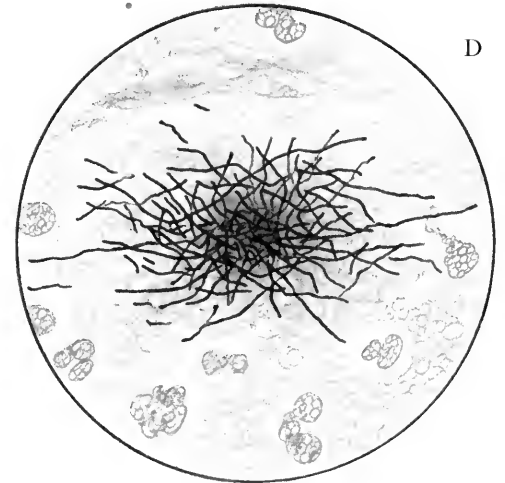
A. Two films of pus from urine counterstained with Löffler's methylene blue after previous treatment with strong carbol-fuchsin (Ziel-Neelson's method). A large cluster of tubercle bacilli is seen in one half of the field, and in the other, four bacilli only are seen as red rods.



B. Shows a film of sputum in the upper half of the field, with many tubercle bacilli, and the same organism in large numbers from a culture in the lower half.



C. Film of pus and many *B. coli communis* from a urinary deposit in a case of pyuria. Note the varying size of the bacilli many of which are in pairs. Stained with Jenner's dye.



D. Film made from pus and a small granule, in a case of actinomycosis. Stained by Gram's method and counterstained with weak carbol-fuchsin. The branching mycelium of the actinomycetes is well shown.

majority of cases it occurs alone, but in a large number of specimens *streptococcus brevis* appears as a secondary organism. Other bacteria accompany *b. coli* in a certain proportion of cases; they are *staphylococcus albus*, *staphylococcus aureus*, and *bacillus pyocyaneus*.

Next to *b. coli* in order of frequency as a primary infection the *b. tuberculosis* may be placed. The staphylococci and streptococci are not very often found alone.

B. tuberculosis is nearly always accompanied by *staphylococcus albus* and sometimes by the other organisms named above. Points of practical importance in the investigation and recognition of tubercle bacilli in the urine are as follows. Tubercle bacilli do not grow on ordinary media, therefore a positive cultural test cannot be obtained in this way. The bacilli grow on special media, but very slowly (see p. 113). An agar-tube inoculated with the purulent urine containing *b. tuberculosis* alone will be apparently sterile after incubation for twenty-four hours. If a secondary organism is present this will grow in the time. Therefore, in a given case, if the agar-tube is sterile or shows *staphylococcus albus*, films of the urinary deposit of pus should be stained by Ziel-Neelson's special method and tubercle bacilli searched for. In most cases the bacilli may be found, sometimes very few and sometimes very many. They often occur in large clumps (Plate II. *a*). The absence of growth of other organisms on an agar-slope is strong presumptive evidence of tubercle even though the latter organism cannot be demonstrated. The confusion of the smegma bacillus with the tubercle bacillus cannot occur if the specimen has been drawn off with a catheter. In a non-catheter specimen the two organisms cannot be differentiated, for their morphology and staining properties are the same. It is stated that alcohol takes the red stain out of smegma bacilli more easily than it does from tubercle bacilli; this is contrary to the experience of the writer. The diagnosis of tubercle of the urinary tract is a very important matter, and no risk of mistaking smegma bacilli for tubercle bacilli should be taken. A catheter-drawn specimen obviates this risk.

In tubercle of the urinary tract there is in most cases a good deal of pus, in a few specimens the pus is scanty. In one case the writer found a few tubercle bacilli in a sediment free from pus.

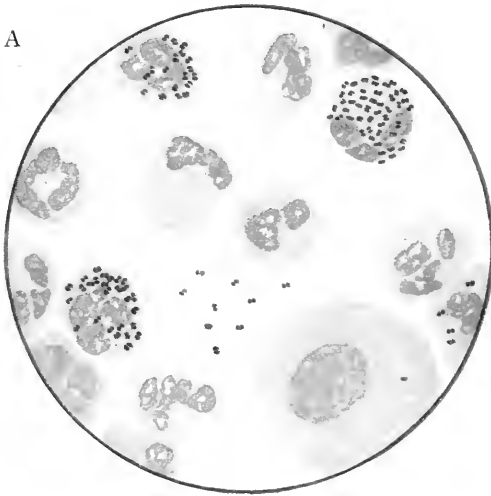
CHARACTERS OF THE PRINCIPAL BACTERIA OCCURRING IN THE GENITO-URINARY TRACT

The Gonococcus.—The gonococcus occurs as a small paired organism, varying from $\cdot 6$ to $\cdot 8 \mu$ in diameter; the cocci resemble two kidneys in shape and are arranged with their concave surfaces opposite each other (Plate III. *a* and *b*). This typical form and arrangement

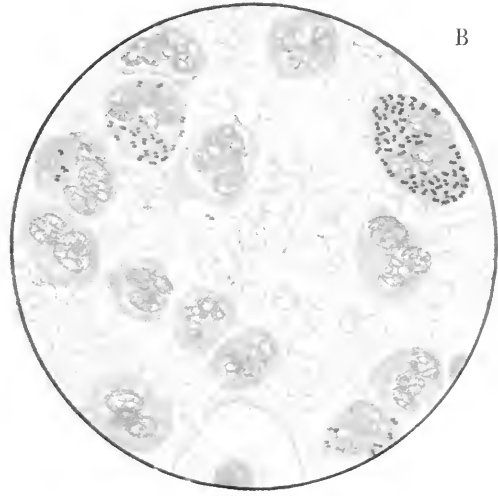
is seen in films made from pus, but in cultures the cocci are variable in size and rounded in shape. In pus the cocci are for the most part found in the bodies of the cells, but they are also seen lying loosely outside the cells. This intracellular distribution serves as one of the means of identifying the gonococcus. As meningococci are also found in precisely similar circumstances, *i.e.* in the bodies of pus-cells, attention must be drawn in a given specimen to the part of the body from which the pus was obtained. Gram-negative diplococci of the size and shape of gonococci found in the pus from the cerebro-spinal fluid are, for practical purposes, meningococci, for a gonococcal meningitis is a very rare disease. On the other hand Gram-negative diplococci occurring in the pus obtained from the urethra, vagina, uterus, or tubes are almost certainly gonococci. Gram-negative staphylococci, however, are sometimes met with in these regions and it is necessary to make cultivations to identify the organism with certainty. The staphylococci grow on ordinary agar with ease, but gonococci do not, as a rule, and it is found necessary to use special media. The simplest medium is agar on which a few drops of sterile fresh human blood have been spread; this medium is easily prepared and answers admirably. Colonies of gonococci appear in about twenty-four hours as flat, round, semi-transparent masses of small size. If the growth is copious the colonies coalesce in the centre, but remain discrete at the margin. The organisms soon die off, and it is exceptional for them to live more than three or four days. Subcultures should be made about every other day on fresh blood-agar, but even with these precautions they soon lose their power of reproduction.

Collection of Material.—Pus from a recent case of gonorrhoea contains a large number of gonococci, but at the later stages of the disease other organisms appear and the gonococci decrease rapidly. The method of procedure differs in the two stages: in the acute stage a little pus may be collected from the urethra or vagina on a platinum loop or small woollen sterile swab; with this make several films on clean glass slides and inoculate one or two blood-agar tubes. If using a platinum loop, inoculate the tubes with the first drop or drops, and then place another large drop on a slide, cover this with a second slide, press down gently, and then draw the slides slowly apart. If too much force is used the pus cells are broken up and the cocci are scattered over the field, thus the intracellular arrangement of the gonococci is lost. If a swab is used, moisten it well with the pus and inoculate a plain-agar tube by drawing the swab lightly up and down the slope; it is best to use two tubes, then add a few drops of sterile blood and 'dab' it gently over the surface. If the swab is drawn over an agar-slope with fresh blood already in position, the swab soaks up the blood, and it is very difficult to leave enough on the tube to act as a medium for the growth of the gonococci. After the tubes have been inoculated make films of pus on two slides by drawing the swab lightly over the surface of the glass. Incubate the tubes and proceed to stain the films on the slides. Use Löffler's methylene-blue for the first slide and stain the other by Gram's method. In the blue-stained film the gonococci are seen as flattened diplococci lying in the protoplasm of the pus cells; the protoplasm itself is unstained and the nucleus deeply stained; a very thin line represents the outer margin of the cell. The picture presented by pus-cells stained with methylene-blue is very characteristic; here and there a cell will be seen containing a varying number of gonococci, and some cells will be found stuffed full with these organisms. Then again loose cocci will be seen

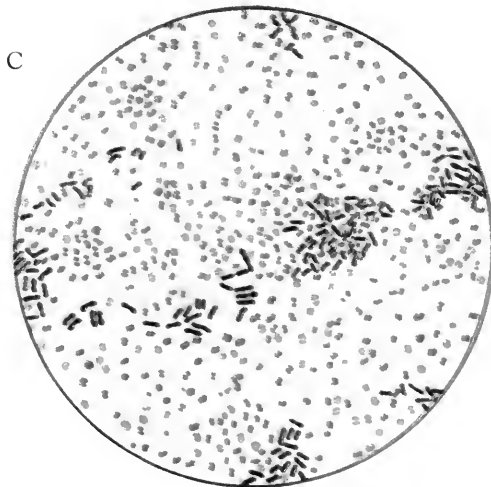
PLATE III. Vol. I



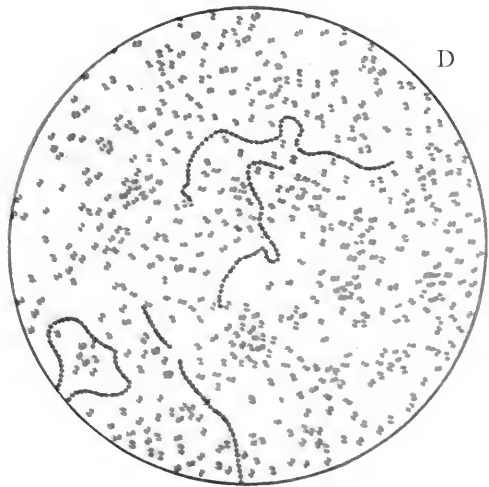
A. Film made from a vaginal discharge stained with Löffler's methylene blue. Note the diplococci (Gonococci) filling several pus cells and others lying free. One squamous cell is seen.



B. The same discharge stained by Gram's method and counterstained with weak carbol-fuchsin. The gonococci are coloured red, thus proving their Gram-negative property.



C. Film made from a mixed culture of gonococci and pseudo-diphtheria bacilli. The gonococci are stained red and are seen to be variable in size. The bacilli have retained the black stain by Gram's method, and are mostly in the form of short thick rods.



D. Film of a mixed culture designed to show the resemblance of *micrococcus catarrhalis* to gonococci; they are small paired cocci stained red after losing the black stain in Gram's method. The streptococci in long chains are Gram-positive.

between the polynuclear cells, and where a pus cell has been broken in making the film the cocci are seen in a straggling group. The second film must be stained by Gram's method and a red counterstain (weak carbol-fuchsin) applied; in this the cocci and cells are found stained red. The Gram-negative property of the gonococcus is thus demonstrated. The blood-agar tubes must be examined later and films made from any growth present. Gram's method of staining is followed to verify the Gram-negative property of the gonococcus.

In a chronic case in which it is desired to see if the gonococci are still present, or in a case of chronic discharge without a positive history of gonorrhoea, the microscopic evidence is very difficult to obtain, and the diagnosis depends greatly on the cultivation test. Films made direct from a vaginal discharge in these circumstances are very unsatisfactory, for they will be found teeming with other organisms, cocci and bacilli, both Gram-negative and Gram-positive. Cultures will in some cases yield a growth of gonococci. If possible, material must be obtained from the cervical canal, for in this region gonococci are always found in the later stages of the disease, and but few other organisms keep them company. The method which answers well is to insert a vaginal speculum—Ferguson's pattern is the best—and obtain a clear view of the external os. Wipe away any loose discharge with sterile wool and push a swab into the canal, gently rotate, and allow it to get well moistened before withdrawing it. If there is plenty of material a platinum loop may be used as well. Always obtain as much material as possible, for a second manipulation is not always possible or desirable. With the material thus obtained films and cultures are made as described above. As a rule very few, if any, gonococci are found in the films, but cultures often show them. The cultures almost invariably yield some colonies of *staphylococcus albus*, pseudo-diphtheria bacilli, or both, with or without the presence of gonococci.

Streptococci.—Streptococci are small round organisms which grow in chains of varying length (Fig. 62); the individual cocci are usually of the same size throughout the chain, but they often vary in size and shape. The cocci may be in chains of pairs, and the individual cocci slightly elongated in shape. The chains may contain from 4 to 6, or 30 to 40 or more cocci. Usually the type found in an individual case is either of the short-, medium-, or long-chained variety, which suggests that there are different types of streptococci, and this is no doubt true. The cocci seen in films of pus measure .6 to 1 μ in diameter but in cultures their size varies a good deal. As a rule the length of the chains is the same in films of pus as when grown on culture media, except that in the case of the long-chained coccus the chains on solid media are usually short. When grown in broth the

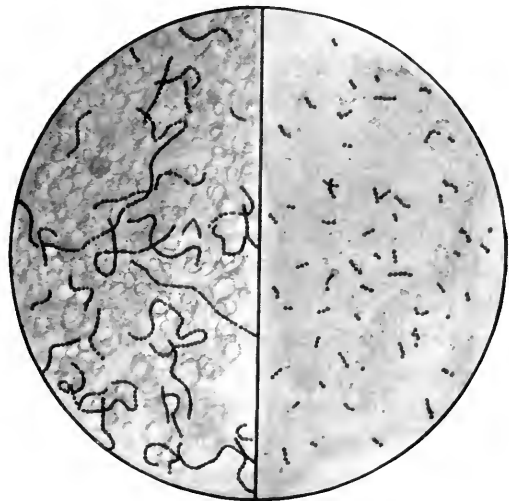


FIG. 62.—Two views of streptococci, one in long chains, the other in short chains. From culture in broth.

chains of this variety assume their maximum length; they also grow long in the condensation fluid at the bottom of an agar-slope (Plate III. d).

Two classifications of the streptococci have been made, the first based on the morphology of the organisms and the second on their biochemical reaction. The first classification includes the *streptococcus tenuis* of Veillin, consisting of chains of 2 to 6 very small oval cocci; the *streptococcus brevis* of von Lingelsheim, in which the chains consist of 4 to 6 diplococci, and the *streptococcus longus* in which the chains are very long. The second classification is based on the chemical reactions obtained when streptococci are grown in fluid media containing various sugars, viz. saccharose, lactose, raffinose, etc. The reactions given by a large number of streptococci from various sources were worked out by Gordon and afterwards by Houston, Andrews, and Horder. Andrews and Horder summarized their results and divided the streptococci into seven groups:

- (a) *Streptococcus equinus*—a saprophytic group derived from herbivorous intestines.
- (b) *Streptococcus mitis*—essentially saprophytic.
- (c) *Streptococcus pyogenes*—a pathogenic type found typically in suppurative lesions; it also includes the streptococcus found in erysipelas.
- (d) *Streptococcus salivarius*—found in the saliva and also in the intestines, a short-chained coccus.
- (e) *Streptococcus anginosus*—a long-chained coccus, found in the mouth, especially in connection with scarlet fever. It is also found in the intestine and less commonly in other parts.
- (f) *Streptococcus faecalis*—the typical intestinal streptococcus, a short-chained variety, not found in the mouth.

(g) *Pneumococci*—occurring in pairs and short chains, and characterized by the presence of a capsule, when growing in the body and on certain special media.

The above classification is not claimed as perfect, but it is an attempt on the part of the authors to differentiate the streptococci into some kind of useful order.

Streptococci are stained by all the aniline dyes and are Gram-positive. They grow well on agar, blood-serum, and in broth at the ordinary temperature of the body. The colonies appear in about twelve hours and in twenty-four hours are fully developed; on the surface of the agar, they are small round dots, slightly raised above the surface. Some are almost transparent and easily rubbed off the media, whilst others are opaque and are firmly adherent. On blood-agar the colonies are larger than they are in plain agar. In broth the organisms sometimes cause a turbidity and form white masses, which adhere to the sides and sink to the bottom of the tube. When obtained from the blood of a case of septicaemia, the colonies form small white rounded masses entangled in the fibrinous clot which forms in a tube of broth into which some blood has been inoculated. They appear usually in twenty-four to thirty-six hours.

The Pneumococcus.—The pneumococcus appears as a small diplococcus in its most typical form, the shape of the cocci being oval or with pointed ends (*diplococcus lanceolatus*). In smears from sputum, pus, etc., a capsule often surrounds each pair and can be demonstrated by special stains, but in culture on artificial media the capsule is in nearly all cases absent, and there is a tendency for the cocci to be arranged in short chains, contain-

ing two or three pairs, sometimes more (Fig. 63). For this reason it is thought by some observers that the pneumococcus is closely related to the streptococci and may even belong to that species. The pneumococcus varies in size from $\cdot 5$ to $\cdot 75 \mu$ to 1 or $1\cdot 25 \mu$; it is easily stained with the basic aniline dyes and is Gram-positive. The pneumococcus is a delicate organism and does not grow on artificial media below 25°C. ; the optimum temperature is 35° to 37°C. On agar small transparent colonies appear in about twenty-four hours; they are discrete and have been compared to drops of dew. Growth occurs in broth, and in this medium the formation of short chains is best seen. They rapidly die, and therefore subcultures must be made every second day.

Staphylococci.—The staphylococci are small round organisms, measuring $\cdot 6$ to 1μ in diameter, generally found in clumps and masses in such material as the pus from abscesses (Plate I. c), etc.; on culture media they occur in very large masses and have been compared to bunches of grapes (Fig. 64). They are non-motile and retain the stain by Gram's method. In fluid media the cocci are

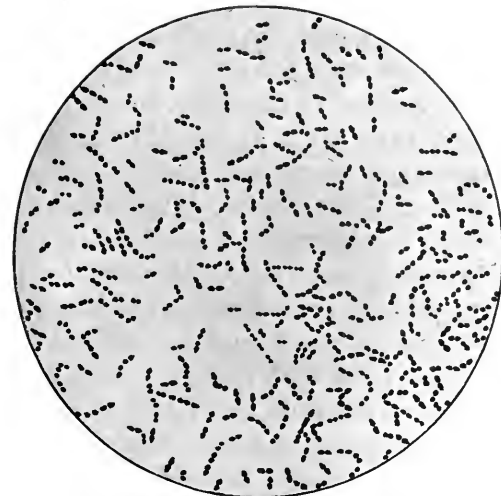


FIG. 63.—Film made from a culture of pneumococci; they are mostly in pairs of rather large cocci which are elongated in shape; there are also many short chains of paired cocci.

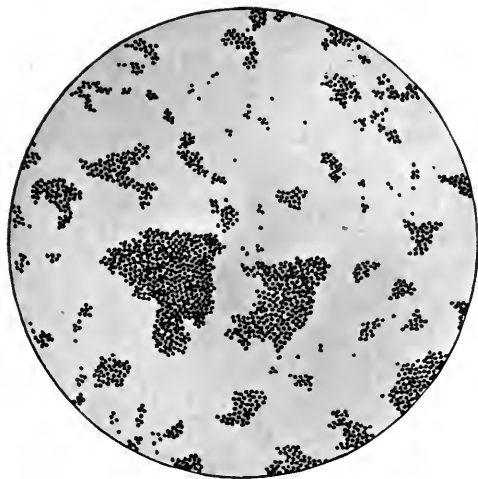


FIG. 64.—Staphylococci showing the grouping into masses. From a culture on agar.

often seen in pairs or short chains of 3 to 4 cocci and cause a uniform turbidity. On solid media, such as agar, the growth occurs readily in twelve to twenty-four hours in the form of large raised colonies in a first inoculation from pus, etc., but in a subculture it forms a thick uniform mass with isolated colonies at the margin of the growth. The cocci grow best at a temperature of 37°C. , but they also will grow at 20°C. , though more slowly.

Classification.—This has been made according to the colour of the growth on solid media, for it is found that some staphylococci grow in deep yellow colonies, others white, and others again in light yellow colonies, hence the division into *s. aureus*, *albus*, and *citreus*.

Staphylococcus aureus is the most important of the three, and is found in boils, carbuncles, abscesses, osteomyelitis, and pyaemia. *S. albus* is very common in the skin, mouth, nose, urethra, vagina, etc. *S. citreus* is rather uncommon and is met with in various kinds of suppurations.

All three varieties may occur in the case of double infection with other organisms. As regards virulence, *staphylococcus aureus* may be taken as the most serious, but occasionally the other two may also cause very serious lesions, such as septicaemia. *S. albus* has been divided on biochemical grounds into two varieties, *s. epidermidis albus* and *s. pyogenes albus*, but their reactions are not constant, and both may be met with in very severe lesions; on the whole, however, *s. albus* occurs a great deal more frequently in mild lesions than the *s. aureus*. The *s. albus* is a very common inhabitant of the urethra, vagina, and cervix.

Bacillus Diphtheriae.—The diphtheria bacillus varies greatly in size and shape; in its general characteristics it is a small, slender rod, straight or slightly curved, with rounded or swollen ends. Its length varies from 0·8 to 5 μ . The bacilli are typically arranged in parallel and crossed masses and bear a resemblance to the arrangement of Chinese letters. They are non-motile and do not form spores. By Gram's method they retain the stain uniformly, but weak methylene-blue reveals an irregular bead-like structure. The beads may be at the ends (polar bodies), or distributed along the body of the bacillus giving it the appearance of a chain of cocci. Neisser's stain colours the body brown and the poles deep blue or violet. Toluodene-blue stain colours the body a very pale blue and the polar bodies red or very deep blue.

The diphtheria bacillus grows well at 37° C. on coagulated blood-serum, and colonies appear in six to eight hours. It will grow also on agar and in broth, but more slowly. The colonies appear as greyish-white points, which grow to the size of a pin's head, more opaque at the centre than at the margin. The bacillus forms acid in glucose-litmus broth, and is pathogenic for the guinea-pig. For usual diagnostic purposes blood-serum is used, and at the end of about eight hours some of the growth is rubbed off the surface with a platinum loop and spread on a slide with a drop of water; this is dried and stained for three to five minutes with toluodene-blue stain. The characteristic polar-stained bacilli are then easily seen when examined with the oil-immersion lens. When collecting the material for examination, wipe off some of the secretion or membrane with the end of a sterile swab and rub it well on to the surface of the blood-serum. Other organisms are usually present, but the diphtheria bacilli are easily distinguished. The preliminary examination of a stained film made direct from the swab should always be made, for it is often possible to make a diagnosis at once from the presence of a large number of bacilli. A negative examination, however, does not exclude diphtheria and a cultivation should be made on blood serum.

Bacillus Pseudo-Diphtheriae.—Under this heading there are at least two varieties of bacilli, both of which are very commonly found in the cervix uteri. The first, which corresponds to Hoffmann's bacillus and is also a common inhabitant of the throat, is an oval-shaped bacillus, non-motile, and Gram-positive; it is shorter than the true diphtheria bacillus and exhibits a greater uniformity in size (Plate III. c). The growth on agar is more rapid and the colonies larger and nearly white. No acid is formed in glucose-litmus broth and the bacillus is not pathogenic for the guinea-pig. It is probable that this organism is identical with that found in the conjunctiva in cases of xerosis.

The second variety, which is the more common, is of larger size and of variable thickness and length, more nearly resembling the true diphtheria bacillus. It is also non-motile

and Gram-positive. It grows slowly and forms very small opaque white colonies on agar, resembling some of the streptococci. On examination with a hand lens the colonies are seen to be crenated and the surface crinkled.

Both these types of bacilli may be found in the same lesion. They are found also in the urethra of both sexes, in the uterus, suppurating ovarian cysts, pyosalpinx, skin-sinuses, mouth, and nose. In most instances the pseudo-diphtheria bacilli are accompanied by other organisms, especially the staphylococci. They are nearly always present in the later stages of gonorrhoeal infection of the urethra and cervix. The writer is of opinion that these bacilli, together with the *staphylococcus albus*, are the offenders in keeping up the discharge in all old cases of gonorrhoea in both sexes.

Bacillus Tuberculosis.—The tubercle bacillus is the cause of tuberculosis occurring in many parts of the body. Recent work has shown that there are several varieties of this organism, and also that its simple bacillary form is not constant; there are found all grades between a short rod-shaped organism and long branching filaments of the streptothrix type. The tubercle bacillus varies from 2 to 3 μ in length and from 0.3 to 0.5 μ in breadth; the bacilli are usually slightly curved, but many appear straight; the size and shape vary a good deal in cultures according to age and the medium employed, but the above figures give a fair idea of the bacilli as seen in smears made from sputum, etc. (Plate II. a, b). The bacilli are coloured by the ordinary aniline dyes, although not readily, and retain the stain by Gram's method. A characteristic feature of the tubercle bacillus is its power of retaining the carbol-fuchsin stain after treatment with dilute mineral acids; this feature it shares with several other organisms, such as the smegma bacillus, leprosy bacillus, and some types of actinomyces. The stain must be strong and heat is required, or else a long immersion in the cold, for the stain to penetrate the fatty or waxy covering of the bacilli.

The tubercle bacillus can be cultivated on artificial media, such as coagulated egg- and glycerine-agar. On the former medium it is now possible to obtain direct cultures from such material as urine, cerebro-spinal fluid, and tuberculous abscesses, but to induce primary growth on glycerine-agar it is necessary first to inoculate animals with the infected material. Growth occurs slowly at 37° C. and takes about a week to appear on egg-medium, when moist greasy-looking colonies appear.

Smegma Bacillus.—This bacillus is found in normal smegma; it is a narrow organism of varying length and exactly resembles the tubercle bacillus. The bacillus is acid-fast, and according to some authorities is more easily decolorized by acid alcohol than the bacillus of tubercle; this, however, is doubtful. The organism has not been cultivated outside the body, and its presence in any other locality than the preputial region has not been proved. The smegma bacillus corresponds to that first described by Lustgarten as being the organism causing syphilis. Its importance to the pathologist lies in its resemblance to the tubercle bacillus, for it may give rise to difficulty in the examination of urine. This point is dealt with above.

Actinomycosis.—The organisms causing this disease belong to the genus *Discomyces* and form a large group. The parasite is only occasionally found in the female genital organs, and here it is mostly found in the Fallopian tubes and ovaries, usually by extension

from the region of the vermiform appendix. Only a brief account of the general characters of the organism is necessary here. The parasite forms small yellowish or white grains lying in pus, and on microscopic examination these are seen to consist of mulberry-like masses composed of a central collection of branching filaments with diverging rays, in many cases club-shaped at the free end. The filaments retain the stain by Gram's method and in a few varieties of the fungus they are acid-fast (Plate II. *d*). Mixed with the filaments are rod-shaped bacillary forms of various lengths. The actinomyces may be cultivated, and grows slowly on various media, the best results being obtained on glycerine-agar under anaerobic conditions. No clubs are found in cultures and the short forms predominate especially in the early stages.

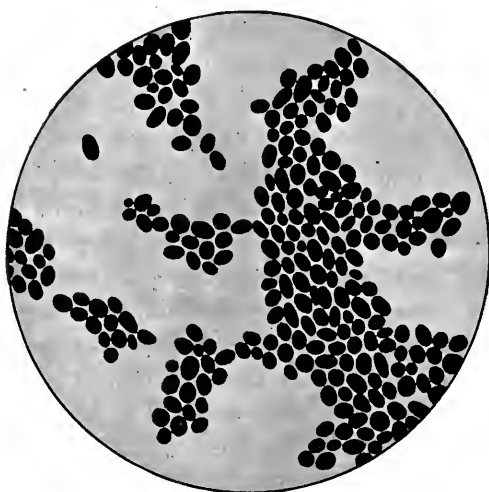


FIG. 65.—Film from a cultivation of the thrush fungus (*saccharomyces albicans*). Ovoid and rounded bodies of large size are shown with also a few small 'buds.'

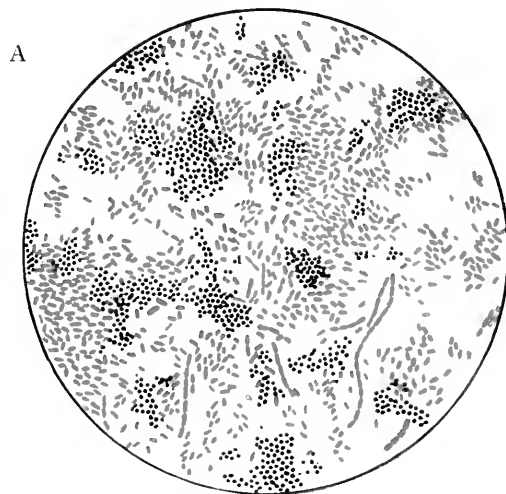
Saccharomyces Albicans.—This parasite occurs frequently in the vagina in combination with other organisms. In films made from a vaginal discharge the mycelium is seldom seen and only a few of the ovoid or rounded corpuscles are found. But on cultivation a large number of dead-white colonies appear on an agar-slope in about twenty-four hours (Fig. 65). Under the microscope the corpuscles are well demonstrated by Gram's method of staining; they are mostly large bodies, but many small ones appear and budding is always seen.

Bacillus Coli Communis.—The colon bacillus is a small rod-shaped organism, with rounded ends; it varies a great deal, however, in length, from 2 to 3 μ upwards, being more uniform in tissues and cultures on solid media, and attaining greater length in urine and in fluid media. It is a motile organism and does not retain the stain by Gram's method. By special staining methods flagella can be demonstrated in small number, usually about four to six. The bacilli can be stained by the aniline dyes and show up well with methylene-blue and weak carbol-fuchsin (Plate IV. *a*). The motility varies a great deal in different strains, all stages from active movements down to non-motile bacilli being met with.

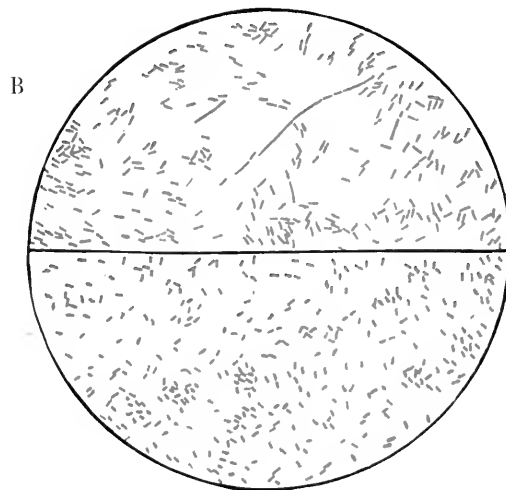
Cultivation of the colon bacillus is easy and a broth tube inoculated with it develops a marked turbidity in a few hours. On agar, colonies appear in a few hours and attain a large size in twelve hours; if the organisms are very numerous, the growth appears as a uniform whitish layer with a few separate colonies at the margin. The growth is soft and easily detached and it is raised well above the surface. The colon bacillus does not liquefy gelatine, it forms gas and coagulates milk. The medium is also made acid, neutral red is reduced, and indol is formed.

Bacillus coli communis is a normal inhabitant of the large intestine and therefore is practically always present about the region of the anus, perineum, and vulva; this is an

PLATE IV. Vol. I



- A. Film made from a culture of *B. coli communis* and stained by Gram's method. The bacilli vary in size, and some are in chains. They retain the carbol-fuchsin stain after losing the black of the Gram's stain.



- B. Films made from cultures of *B. typhosus* (upper half) and *B. pyocyaneus* (lower half). The resemblance, in form and size, to B.C.C. is shown. They also are Gram-negative.

important point to remember in connection with the bacteriological examination of the urine. Nearly all specimens of urine passed in the ordinary way will be found to contain this organism; if only a few bacilli are washed off the mucous membrane about the urethra at the time of micturition, large numbers will be found after a few hours, for the urine is an excellent medium for their growth. Bearing in mind these facts it is always wise to procure a catheter-specimen of urine when a bacteriological examination is required. As a broad general rule it may be stated that when urine which has been voided naturally is found to contain *b. coli* and is free from pus, the bacilli have reached the urine from an outside source. Exceptions, of course, occur, for cases of pure bacilluria are met with occasionally. Then again pus and *b. coli* are found in the urine, in cases with a vaginal discharge. This may lead to a wrong diagnosis of pyuria with *b. coli* infection. The writer is anxious to make these points quite clear, for he is constantly receiving specimens of urine which have been passed in the ordinary way for bacteriological examination, and therefore the presence of *b. coli*, with or without a little pus, often leads to a false alarm of bacterial infection of the urinary tract. In some cases with the passage of large amounts of pus on repeated occasions when urine is voided, the diagnosis of pyuria is practically certain. The rule for obtaining a catheter-specimen in all cases cannot always be adhered to, for there is the personal factor to take into account; some patients object to this procedure and then one must do the best under the circumstances. Most patients, however, can be made to realize the importance of the little manœuvre and will allow it to be performed.

Bacillus Typhosus.—The typhoid bacillus resembles exactly the colon bacillus in its size, shape, and staining reactions; it is motile to a varying degree as there are various strains of the organism (Plate IV. *b*). Flagella are, however, much more numerous. It grows well on all media but there are important differences in its reactions—gas is not formed, indol not produced, milk is not coagulated, acid is not produced. Serum from an animal immunized against the typhoid organism agglutinates this bacillus in a dilution of 1 in 40. On Conradi-Drigalski plates the medium retains its violet colour, whereas the growth of *b. coli* causes a change from violet to pink.

In a suspicious case it is necessary to perform the above tests in order to make sure whether one is dealing with a typhoid case or not.

Bacillus Paratyphosus, A and B.—Organisms closely associated with the *b. typhosus* and differing from it in certain cultural reactions.

Bacillus Pyocyaneus.—This is a small rod-shaped organism with rounded ends and of variable size. Its average length is $1.5\ \mu$, it is actively motile, does not form spores, stains easily with the aniline dyes, and is Gram-negative (Plate IV. *b*).

The bacillus grows easily and quickly on the ordinary media at 37°C ., and its growth is characterized by the production of a green pigment; on agar the growth spreads over the surface in twenty-four hours, and a fluorescent green tinge stains the medium throughout by the following day. Broth and gelatine also become coloured.

This organism is the cause of the blue or green pus occurring in wounds and nearly always occurs in conjunction with other pyogenic bacteria. It also occurs sometimes in urinary infection, and general blood infections have been recorded. Its appearance in a ward is ominous, for it is easily carried to other cases with suppurating wounds. Fortunately

in most instances it is fairly easily destroyed by biniodide of mercury lotions, but sometimes it is very difficult to dislodge. Wounds in the lower abdomen and pelvis are the most common sites of infection by this organism, especially wounds which lie close to or communicate with the large intestine.

Bacillus Aerogenes Capsulatus.—A large bacillus which is found in the body post-mortem and which causes extensive gas-formation in the liver and other organs; it also produces a gaseous condition in the situation of wounds in loose connective tissue, such as is found in the pelvis. It usually enters the blood stream just before death and no doubt hastens that event, and very likely is the cause of death in some cases. The *bacillus aerogenes* is a large rod-like organism, measuring 3 to 6 μ in length and about the same thickness as the anthrax bacillus. It often occurs in pairs, sometimes in chains, and occasionally filamentous forms are met with. It usually shows a well-marked capsule. It retains the stain by Gram's method. It grows well on ordinary media, but only under anaerobic conditions. It is non-motile and does not form spores. In stab-cultures on agar it forms an abundant whitish growth. Gas is formed in abundance in cultures.

Bacillus Tetani.—The tetanus bacillus is a long, slender organism, 3 to 4 μ in length; it is motile, forms spores, and retains the stain by Gram's method. It is an anaerobic organism and grows well on ordinary media.

Bacillus Maligni Oedematis.—The bacillus of malignant oedema is a rod-shaped organism measuring 3 to 15 μ . It is motile, forms spores, and retains the stain by Gram's method. The bacillus is an anaerobic organism.



FIG. 66.—Films made from the discharge obtained from specific ulcers, both prepared by the indian-ink method. In one half is seen the *treponema pallidum* in the form of a closely folded white spiral. In the other is shown for contrast the *spirochaeta refringens* (non-specific); the spirals are wide and the organism is thicker than the *t. pallidum*. Several organisms are shown in each film. The large white bodies are pus-cells.

Treponema Pallidum.—*Treponema pallidum* is the name given to the organism which is the infecting agent in syphilis. It was first observed by Bordet and Gengon, but Schaudinn and Hoffmann were the first to describe it in 1905, and to them is due the credit of definitely identifying it with the disease. Hoffmann named the organism *spirochaeta pallida*, but owing to differences from the other spirochaetae the term *treponema pallidum* is now generally used.

All the evidence goes to prove that the *treponema pallidum* is the specific organism in the causation of syphilis. It has been found by observers in all parts of the world in the lesions of the primary and secondary stages; it is present in congenital syphilis and in the nervous system in late lesions. It is found in the blood stream. The organism may be cultivated. On the other hand, it is never found in persons free from syphilis or persons suffering from other diseases.

Monkeys have been infected with the disease by inoculation of fragments of gummata and blood. Noguchi was able to produce typical syphilitic lesions in rabbits by inoculating them with pure cultures of the *t. pallidum*.

The *treponema pallidum* is a small spiral filament with pointed ends and usually measures 10 to 15 μ in length. It is actively motile and in the fresh state when examined under the dark-ground illumination the movements are seen to be those of rotation and flexion. The turns of the spiral are regular and average six to twelve in number (Fig. 66). At each end there is a filament like a bacterial flagellum but there is no undulating membrane.

The organism stains with difficulty and always very lightly; it is Gram-negative.

In order to arrive at a diagnosis in a suspected case of recent syphilis the following plan may be adopted. Scrape the surface of a sore with a small sharp knife and collect some of the serum, or the mixture of blood and serum, on the blade of the knife. If there is enough fluid draw some up in a fine glass pipette. There are three methods of treating this material. (1) Make films on a glass slide, dry and stain by some process, *e.g.* Giemsa's stain. (2) Dark-ground illumination. (3) Mix with a drop or two of indian ink, place another slide on top of this mixture and press together, then draw the slides apart. The ink method is very simple and efficient, but the dark-ground illumination method is the best. Unfortunately the latter requires a special apparatus. With the ink-process it is only necessary to dry the film, place a drop of oil directly on to the surface, and then examine with the oil-immersion lens. The *treponema* appears as a transparent body on a dark background of ink, the organism is unstained.

Mucous papules in the throat may be examined by the same methods, but in this case a piece of the sodden mucous membrane is picked off with a pair of fine forceps. It must be remembered that by the time mucous papules appear it is practically always possible to diagnose the disease by submitting the blood to Wassermann's test.

In using Giemsa's stain, fix the films in absolute alcohol for twenty minutes, dry, and place the stain (one drop of stain and 1 c.c. distilled water) on to the film for fifteen minutes. Wash and dry. Examine with oil-immersion lens.

METHODS OF EXAMINATION

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(Birmingham)

GENERAL AND INTRODUCTORY

IN the investigation of disease affecting the female pelvic organs two paths of enquiry are available. These correspond in a broad sense to the methods commonly employed in other branches of medicine and surgery, and may be defined as (*a*) subjective, or method of interrogation, (*b*) objective, or method of direct examination.

As a general rule the investigation comprises both factors, but occasionally it is necessary to form a diagnosis upon information derived from one source only. It may happen, for instance, that a patient is unable to give any lucid account of her symptoms, as in the case of the weak-minded, or when the powers of speech or hearing are defective. On the other hand, with young girls and unmarried women a complete examination of the pelvic organs is usually undesirable, and under such circumstances an opinion must be expressed upon the result of the anamnesis only. It need hardly be said that whenever possible direct examination of the diseased organs should be used. Gynaecology has the advantage of employing very exact methods of diagnosis, and in by far the majority of cases an opinion can be formed from complete objective examination without the assistance of facts derived from the history. Such proficiency, however, may only be acquired as the result of long practice and experience, and the usual method is to compare and correlate the physical signs found on combined examination with the information derived from direct questioning. At the outset it should be noted that whatever methods of examination are employed, the examiner must not rest content with simply observing the picture presented, but should endeavour to build the individual bricks into a complete structure. There is to-day perhaps too frequently a tendency to hazard

several alternative diagnoses rather than to perfect diagnostic methods and powers to such an extent as to bring the possibilities in a particular case to a single conclusion. It is here that the operating gynaecologist possesses an advantage over the general practitioner. He knows the methods that he has employed in examination, and is frequently able to verify the results of his diagnosis by operation. Errors are recognized and faulty methods of examination discarded. It is in fact only by information so gained that efficiency in the interpretation of physical signs can be obtained. The present section is devoted to a description of those methods of examination, which experience has shown to be most generally useful in the investigation of disease affecting the female pelvic organs. It is only within comparatively recent years that gynaecological diagnosis has been placed upon a firm basis. With the evolution of our knowledge perfection in the physical methods of examination has taken place, and to-day the specialty occupies a position on a level with all other branches of internal medicine.

In contrasting the examination required to form a correct diagnosis, in the case of symptoms referred to the female pelvis, with investigation of a pathological condition of other systems of the body, there is, however, one essential difference, viz. that difficulties are only too frequently introduced by the patient herself. The necessary details are naturally very distasteful to the majority of patients, who dread the ordeal, and often unconsciously hamper the examiner and almost prevent him from arriving at a correct diagnosis. Nevertheless much of the nervousness exhibited by patients, which proves a bar to thorough and complete examination, may be dispelled by a kind and reassuring manner on the part of the surgeon. There is without doubt no branch of medicine where more tact in dealing with a patient is required. A kind and confident manner will do more towards steadying the nerves of a highly-strung patient than any amount of firm measures or unnecessary fussiness. The women who seek the aid of the gynaecologist are frequently highly-strung, with nervous systems still further taxed by the suffering through which they have gone. Anxious to be relieved from the vicious circle in which they live, they yet shrink from submitting themselves to the examination requisite to their cure, and unconsciously throw serious obstacles in the way of the physician. Time is well spent therefore by obtaining a patient's confidence before any attempt is made at physical examination. This confidence may often be secured when obtaining the anamnesis, and for this reason it is customary to employ subjective before objective methods of examination.

Opinions differ as to the value of the symptomatology as expressed by the patient. It undoubtedly has not the same pressing importance as direct modes

of enquiry, but in many cases is of considerable value in locating disease to one or more organs. Also time spent in listening to a patient's symptoms affords the surgeon an opportunity of observing his patient and permitting her to become accustomed to her surroundings. The whole interview should never appear hurried, and although facts gained by interrogation may not have a great weight contrasted with information obtained by physical examination, the time thus spent is not wasted.

THE ANAMNESIS

The value of the symptomatology undoubtedly depends much upon the character of the patient herself, and various factors which tend to give rise to false impressions must be considered. As a result of temperament for instance, a similar condition in different women produces a diversity of symptoms. What one patient may describe as a most unbearable symptom is hardly appreciated by another, although the physical signs in each case are identical. Symptoms are very much under the control of the emotions, and it follows that in patients of emotional tendencies exaggerated statements are by no means infrequent. External impressions and suggestions also influence many patients to an astonishing degree, and this is very liable to introduce difficulty in obtaining a trustworthy anamnesis. Unless the physician is particularly careful in his interrogation he may draw statements from a patient which are totally incorrect. Thus leading questions should never be employed, inasmuch as the majority of patients almost invariably give the answers directly expected of them, incorrect though they may be. At the commencement of the interview it is perhaps better to allow a patient to explain in her own way the symptoms pertaining to her condition. When she tends to wander from the point, it is a simple matter to direct her train of thought back again into the required direction. At the same time many women frequently forget or omit the most important points requisite for the diagnosis. This may be the result of modesty or nervousness, and therefore a few questions are usually necessary as to the function of each of the organs involved.

In a general way two classes of patients present themselves for examination. The one appear to derive much pleasure from discussing their symptoms, magnifying every unimportant detail, and frequently taxing the patience of the physician to whom they tell their story; the other class are nervous and retiring, and it is often a matter of considerable difficulty to elicit any facts which have a bearing upon the condition present. It is also unfortunately by no means uncommon for deception to be practised by a patient towards her medical attendant, as in

the case of the malingerer who desires to obtain some pecuniary or other benefit. Occasionally no obvious cause for such deception is present, the only indication being an apparent want of sympathy or a craving for attention. These and other considerations all tend to detract from the value of statements made by a patient.

Symptoms.—Although the complaints expressed by patients vary very considerably, a broad classification of symptoms may be admitted under the following headings: (1) Pain. (2) Abdominal swelling. (3) Vulval swelling. (4) Haemorrhagic discharges. (5) Purulent discharges. (6) Prolapse of the uterus.

Pain is by far the most common symptom, and is usually referred to one or more of several sites. The most frequent position is the lower lumbar or sacral region. Next in frequency is the left iliac fossa; this is often called ovarian pain, although the relationship rests upon very little real evidence. Pain is also occasionally located beneath the left mamma, a point on which considerable emphasis was laid in the older text-books on gynaecological medicine.

In the investigation of this symptom, information should be elicited as to its site, duration, and character, and its relation to the menstrual function. The *character* of pain is often of considerable value in locating the lesion; thus, the dull aching pain of pelvic congestion and inflammation must be distinguished from the sacralgic and bearing-down pain so often associated with uterine displacements. Again, the presence of paroxysmal colicky pain may indicate the existence of a polypoid uterine neoplasm, or products of conception, either within the uterus or Fallopian tube. The relation of the symptom to menstruation will be dealt with in its proper section. It is sufficient here to observe that its character, location, and duration under such circumstances should be very carefully investigated before any physical examination is conducted. In estimating the *severity* of pain, difficulty is often introduced since, as previously stated, some women are able to endure considerable discomfort without complaint, whilst in others with less stable nervous systems life is made miserable by lesions which in the former produce only passing discomfort. In attempting to gauge its severity, it is a good plan to enquire whether the symptom is relieved by rest, or whether it is the cause of insomnia. Thus the dragging pain associated with uterine prolapse is almost invariably relieved when the patient assumes the recumbent position. This is frequently the case also in pelvic venous stasis and inflammatory conditions. On the other hand, pain associated with cancer and other neoplasms appears to be accentuated by rest, probably because the causative factors are not relieved, and the patient's attention is more directly concentrated upon her symptoms.

Not infrequently it happens that patients complain of pain in the pelvis when

after careful examination no cause for it can be detected. There is in fact a hyperaesthesia of any and every part of the pelvic viscera. In such a case careful note should be made of the fact, since undoubtedly many of these patients are submitted to various operative procedures without obtaining the least benefit from them. It is this type of patient that tends to throw discredit upon surgery, and it is only by very careful observation and close attention to the characters of the so-called pain that such mistakes can be avoided.

Abdominal and other Swellings.—In the examination of a swelling referred either to the abdominal or vulval region, the main points in the history which require investigation are first its duration, and secondly its relation to pain and discomfort. As regards abdominal tumours, it is surprising how frequently very large neoplasms are unnoticed by patients, and until definitely pointed out by the practitioner the patients are unaware of their existence. Unless a tumour produces symptoms due to pressure upon other organs in the pelvis, it is usually not recognized by the patient until it has assumed moderately large proportions. For this reason, the duration of growth as stated by the patient tends to be misleading. Enquiry should be instituted as to any very rapid variations in size and to the occurrence of attacks of pain. Note must also be taken of the general effect produced upon the patient's metabolism by the neoplasm, particularly in respect to wasting and the incidence of asthenia and anaemia. Questions may be asked relative to the occurrence of any abnormal movement noted within the abdomen by the patient. Such of course occurs during pregnancy, but may also be produced by freely movable neoplasms, particularly if pedunculated. Intestinal peristalsis should also be noted as a cause of abnormal subjective sensations. In the case of swellings in the vagina and in the neighbourhood of the vulva, recognition by the patient usually occurs at a much earlier stage owing to the discomfort produced on walking and sitting. Information submitted as to duration is therefore much more reliable in such instances than is the case with abdominal tumours.

Haemorrhage from the genital tract is a symptom of great frequency and importance, and considerable care is necessary in the successful elucidation of its cause. When a patient complains of a discharge of blood, information should be obtained as to its duration, its relationship to the menstrual cycle and to pregnancy, labour, or abortion, its effect upon the general condition, and the production of anaemia. It is also necessary to enquire in detail as to the phenomena associated with the catamenial functions when in health, particularly as to the age at which menstruation began, the duration of the cycle, and the customary amount of blood lost. The habitual or occasional passage of clots should be noted and also the

colour of the discharge. An accurate knowledge of these facts is required in each case, since individual variations, not only in type but also in the amount of blood lost, occur so frequently.

Other Discharges.—When a patient complains of discharge other than blood, questions should be asked relative to its duration and mode of onset, particularly whether sudden or gradual. It is also important to note the characters of the discharge, particularly as to whether it is profuse and of watery or purulent consistence. The colour of discharges as given by patients is usually yellow, brown, green, or white. A yellow colour as a rule indicates pus, and is frequently met with in gonorrhoeal and other specific discharges. A brown tint is due to admixture with blood, and occurs frequently in association with various neoplasms and retained products of conception. A green watery fluid is often the result of the breaking down of a malignant neoplasm. It also sometimes occurs in association with necrotic fibroid polypi and other tumours. The natural discharge from the genital passages is white and flaky in appearance. It is designated by the term *leucorrhoea*, and in common parlance is known to patients as ‘whites.’ Occasionally a discharge from the vagina is mixed with urine or faecal material, as when fistulae communicate directly with the bladder, ureter, or intestinal canal. Such a discharge is very irritating and leads to much local discomfort. As a rule patients are able to give direct information as to its character in such cases.

Uterine Prolapse.—Occasionally direct evidence as to a lesion is afforded by the patient, who complains that her “womb falls.” At the same time this condition is so common that it has come to be regarded by the general public as a specific affection. Any swelling in the vagina is thought to be some manifestation of prolapse, and therefore although a patient may refer her condition to this lesion, physical examination not infrequently reveals a totally different cause.

Apart from these general symptoms, each of which indicates special lines of enquiry, one or two other points call for special mention. As, however, these will be dealt with in later chapters no lengthy discussion is here required. One is the question of *sterility*.¹ Although hardly a symptom this condition is so frequently brought to the notice of the practitioner that it is well to note briefly the special points requiring investigation. Information should be obtained as to the date of onset, type, and duration of the menstrual function. Enquiry should also be instituted as to the date of marriage and whether marriage was consummated. Facts must also be gathered regarding the health of the husband, and if possible an inter-

¹ See also Article on Disorders of Function (p. 404).—EDITORS.

view with the latter arranged, inasmuch as the cause of the sterility only too frequently lies with him—a point often overlooked! The physical examination requisite is detailed in a later section. Patients also occasionally complain of dyspareunia and other symptoms referable to the sexual relation. Owing to the delicacy of this matter, however, it not infrequently happens that although the chief trouble lies here, patients avoid mentioning such points, and go out of their way to direct attention away from the essential issue.

In any scheme formulated for obtaining a patient's history, it is important that special headings be inserted relative to the *bladder* and *rectum*, owing to the close association of these tracts with the purely sexual organs. Symptoms referable to the urinary tract are exceedingly common in female patients, and it not infrequently happens that lesions in this system are obscured by symptoms referable to the genital tract and *vice versa*. It is therefore important that the physician should not only be thoroughly conversant with the methods of investigation used by the gynaecologist but also with those of the urologist and proctologist. In this connection it may not be superfluous to remark that prior to the physical examination of any female patient, general enquiries should be instituted as to the function of all the bodily systems. It is insufficient to limit the field entirely to the pelvis, since a patient does not come to the consulting-room labelled with the particular lesion from which she is suffering. Many women visit the gynaecologist who are suffering from disease outside the pelvis, and therefore he should always be on his guard for such cases. It is only by careful attention to routine and detail that mistakes such as these can be avoided. Again gynaecological symptoms sometimes appear in the course of general diseases, and the gynaecologist is consulted because of the symptoms referable to the genital tract. The relationship of pruritus with diabetes, and the association of menorrhagia with diseases of the liver, kidneys, or bladder, may be cited as examples. Enquiries as to the general condition of a patient are frequently of great use in locating a specific lesion. The secondary anaemia subsequent to severe or prolonged haemorrhages, and the toxic conditions which supervene upon chronic inflammation and sepsis, are examples of the general constitutional changes which have their origin in a lesion situated within the pelvis. Finally the relationship of hysteria, neurasthenia, and various other psychoses to disease of the pelvic organs appears in many cases to be so close that symptoms referable to such states cannot be lightly disregarded. The exact etiology and pathology of these conditions is unknown, and until further information is forthcoming, more harm than good is done not only to patients but also to medical science by treating them as being of little

practical importance. The inability to refer a specific symptom or symptoms to any particular organ is due rather to want of acumen on the part of the examiner or to a deficiency in diagnostic methods. It is not compatible therefore with the duty of the practitioner towards his patient to disregard such symptoms and throw them into the gynaecological waste-paper basket.

OBJECTIVE EXAMINATION

Physical examination is the means *par excellence* for arriving at a correct diagnosis in the case of all pelvic ailments in the female. It should be employed whenever possible, but under certain circumstances a complete investigation of the pelvic organs is inadmissible. It is well that these reservations should be clearly defined. In the first place no patient should be examined against her wishes. If, in the case of a married woman, serious objections are put forward by the patient, it is the duty of the practitioner to inform her that such examination is necessary for purposes of diagnosis and treatment, and if she still raises objections he should decline to advise her. It may be taken as a general rule that women must not be examined for trivial causes. Furthermore, no maid-servant should be forced to submit to examination merely at the request of a mistress. Such demands are not infrequently made, particularly in cases of suspected pregnancy. In no instance, however, should the practitioner allow himself to be persuaded without first receiving the consent of the patient and, if under age, of her legal guardian. Needless to say, no local examination should be made upon girls or unmarried women in the absence of urgent pelvic symptoms directly calling for such examination. If an investigation of the pelvis is necessary in these cases, it should be conducted under a general anaesthesia for the sake not only of the patient's feelings, but also to obtain that muscular relaxation without which the examination is likely to prove futile. As a general rule, therefore, a complete examination of the pelvic organs may be conducted with the consent of the patient in (1) married women in whom symptoms indicating pelvic disease are present; (2) unmarried women in whom symptoms pointing to disease of the pelvic organs are urgent and cannot be investigated by any other means; (3) girls at puberty who complain of symptoms suggesting imperforate hymen. Under all circumstances a relative or friend of the patient should be present during the examination. This should be insisted upon in the case of unmarried patients, notwithstanding the difficulties that are sometimes raised by patients themselves.

It has been noted in the case of the anamnesis, how important it is to employ a systematic routine in every case in which physical examination is employed.

The purpose of such an investigation is to ascertain the condition of the genital tract and adjacent organs, but previous to this a general survey should be made to include the investigation of all the bodily systems. Thus, attention should be directed to the cardiac, renal, alimentary, pulmonary, and nervous systems. As these matters are fully dealt with in books on general medicine, no further reference to them need be made. In the local examination of the pelvic organs, one or more of the following methods are employed: (1) abdominal examination, (2) vaginal examination, (3) rectal examination, (4) bimanual examination. In addition to these, use is frequently made of various auxiliary methods. These may be classified as follows: The employment of vaginal specula, the uterine sound, the use of volsella and tenacula, macroscopical and microscopical examination of tissues, bacteriological examination of the genital tract, examination of discharges from the genital organs, cystoscopy, radiography, and haematological examination.

ABDOMINAL EXAMINATION

The first step in routine examination should be a thorough examination of the abdomen. By this means lesions developing above the pelvic inlet are appreciated, and unless it is always employed as a part of the regular routine serious mistakes will arise. The examination should include (*a*) inspection, (*b*) palpation, (*c*) percussion, (*d*) auscultation, (*e*) the preparation of photographic or diagrammatic records. For its successful accomplishment certain points in general technique should be observed. The patient lies in the dorsal position with her head and shoulders slightly raised and supported, and the thighs partly flexed and externally rotated. All impediment in the way of dress, skirts, and corsets must be removed, and a rug placed over the lower extremities. It is most essential that no constriction of the chest, such as is produced by a closely-fitting corset, be present, since it produces such protrusion and rigidity of the lower abdominal zone that palpation may be rendered futile. For these reasons examination of the patient in bed is in many respects desirable. If, on the other hand, the examination is conducted in the consulting-room, a loosely-fitting dressing-gown may be worn. The time of day at which the abdominal examination takes place is not without importance, inasmuch as during the first hour or two after a heavy meal distension of the gastro-intestinal tract may introduce difficulties and obscure the essential issue, as well as being distasteful to the patient. Morning is undoubtedly the best time for any abdominal investigation, and precautions should be taken to have the bladder and rectum emptied before the investigation

is undertaken. It is a good rule to have the urine passed immediately before the examination and reserved as a specimen for routine analysis. Before the examination is commenced, the patient should be made as comfortable as possible, and all care taken to avoid unnecessary fussiness which only tends to alarm her and eventually render the subsequent manipulation difficult by establishing a condition of unconscious muscular rigidity.

Inspection of the abdomen determines any obvious changes in shape or contour. Thus, in cases of free ascites, the abdomen appears abnormally flat and the width is increased. The abdominal distension from peritonitis on the other hand is generally diffuse with no lateral bulging. Any undue irregularities or protrusions should be noted, such as are produced by new growths. Inspection also includes the observation of all changes in the skin covering the abdominal parietes, for example—the presence of dilated veins, striae, pigmentation, or cutaneous eruptions. A note should be made of the condition of the umbilicus, particularly as to whether it exhibits any protrusion. Furthermore the respiratory movements of the abdominal wall must be closely inspected, particularly in cases of inflammatory disease within the abdomen, since they form a valuable indication of the degree of extension of such conditions. The examination must also include the demonstration of intestinal peristalsis. In cases of doubt, peristalsis may often be induced by gently flipping the abdomen with the finger. Under the same heading of inspection may be included a note on the appearance of the mammary glands. This is particularly important in the diagnosis of pregnancy, and a careful investigation of the appearance presented often affords a valuable clue to the nature of otherwise obscure symptoms. In certain cases where an abdominal or combined examination is refused, the condition of the breasts may be observed during an examination of the chest. The special points to be noted during pregnancy are fully described in textbooks on obstetrics, and it is therefore sufficient here merely to mention the salient features. These are the presence of superficial dilated veins, pigmentation of the areola, and the formation of a secondary areola, prominent and tender nipples, general fulness of the gland, and the exudation of fluid on pressure. Both in the observation of the respiratory movements and in the location of any abnormal swelling, a more exact impression may be obtained by kneeling at the side of the patient and bringing the line of vision directly parallel to the free surface of the abdomen.

Palpation forms the most important part of the external abdominal examination. By its means the shape and mobility of various tumours are appreciated. Tender and sensitive areas can be mapped out, and the consistency of any abnormal

swelling recognized. To be successful certain details must be observed. On no account should the hands be cold, since the sudden shock almost invariably produces contraction of the abdominal muscles and prevents the examiner from successfully palpating the underlying viscera. Both hands are placed flat upon the abdomen (Figs. 67 and 68), and the pressure which they exert should as far as possible be uniform. Although impressions are gained chiefly through the finger-tips, any attempt at pressing deeply with the finger-tips is to be avoided, since pain and muscular rigidity are thereby produced. Much more information is gained by gentle



FIG. 67.—Abdominal palpation. The hands are placed in contact with the patient's abdominal wall, the fingers pointing towards the pubes. The shoulders and thighs are slightly elevated.

and sustained pressure than by severe, prolonged, and painful efforts exerted in an endeavour to reach the deep structures obscured by muscular rigidity. If such rigidity is once established, it is frequently no easy matter to effect complete relaxation without having resort to an anaesthetic. An attempt may perhaps be made to withdraw the patient's attention from the matter in hand by engaging her in conversation—a plan which may be adopted with advantage throughout the greater portion of the examination. Relaxation of the abdominal wall is best secured by raising the shoulders and flexing the thighs. If the lower extremities are somewhat abducted and externally rotated, it has been suggested that the uterine appendages are displaced

more forwards, and if enlarged become more easily palpable from the abdomen. It not infrequently happens that palpation is rendered difficult by the presence of faecal matter within the intestines. This difficulty may of course be removed by careful preparation of the patient before the examination takes place. There is a tendency on the part of patients to neglect such preparation, this being specially marked in the case of hospital out-patients. Under such circumstances, with tumours of obscure and doubtful nature, a second examination may be required after a proper course of hospital *régime* has been established. In the recognition,



FIG. 68.—Abdominal palpation. The hands, in the second position, are so placed as to point the fingers towards the costal margin.

by palpation, of the size and consistency of abdominal tumours several factors are concerned. One of the most important is the amount of tissue intervening between the examining hand and the underlying viscus. With the association of extreme adiposity and small deep-seated tumours, it is at times almost impossible to recognize the latter by palpation. The difficulties under such circumstances are even greater in the case of collections of fluid. The consistency of a swelling in the abdomen is, in fact, of considerable importance in recognizing its presence and size. The firmer and harder the mass, the greater is the difference between it and the adjacent structures, and the easier can its boundaries be determined. It is, for example, much easier to appreciate by palpation the size of

a uterine fibromyoma than of the pregnant uterus of corresponding dimensions. If palpation is employed to ascertain the existence of tender areas within the abdominal cavity, care must be taken by the examiner not to produce pain by direct pressure of the fingers, otherwise a false impression may be gained. Fallacy may also arise in the case of extreme superficial hyperaesthesia of the abdominal wall itself. Such is usually recognized by applying extremely light pressure, as by the use of a pin's point or feather. In this connection the relationship of superficial hyperaesthesia to diseases of nervous origin, or to deep-seated lesions within the abdomen, must be borne in mind as pointed out by Head.

Percussion forms a very useful additional means of abdominal examination, particularly in those cases where, owing to rigidity of the abdominal muscles, the presence of an abnormal amount of fat in the abdominal wall, or the soft consistency of an underlying tumour, palpation is of little value. Its chief use is to distinguish between the dull note elicited over a tumour—solid or fluid—and the tympanitic note obtained over the gastro-intestinal tract. It is particularly valuable in the recognition of free fluid within the abdominal cavity, whether such fluid be ascites, pus, or blood. The technique to be observed should follow definite lines. It is best, for example, always to percuss from the resonant towards the dull area, and if possible in a line perpendicular to its boundary. The majority of tumours of pelvic origin are rounded with an upper convex surface. Percussion therefore is usually performed first from the xiphoid process and lower costal margin downwards towards the symphysis, since the tympanitic note over the stomach and colon passes into the dulness over the neoplasm. The percussing fingers should then be carried from the flanks towards the middle line. In the case of solid neoplasms growing from the pelvis, the flanks as a rule emit a resonant note.

It is important to contrast this picture with that which obtains in the case of free fluid within the peritoneal cavity. Here the central area is resonant whilst dulness is well marked in the flanks. As usually expressed, the upper limit of the dull area in the case of pelvic-abdominal tumours is convex, whilst in the case of free fluid it is concave. If the presence of free fluid is suspected, the patient is next placed upon her side and percussion again performed. As the fluid flows into the dependent areas, an augmented area of dulness is observed, whilst the lumbar region, which is uppermost, becomes resonant. This phenomenon, commonly known as "shifting dulness," is absolutely diagnostic of free fluid within the peritoneal cavity.

Although percussion forms a very valuable auxiliary method of examination to palpation, certain fallacies must be recognized. In the first place, a resonant note

may occasionally be elicited over solid tumours owing to the presence of intestine containing gas intervening between the neoplasm and the percussing fingers. One other cause of fallacy may be mentioned, viz. resonance due to the gases of decomposition, *e.g.* physometra. Again, an over-distended colon may give rise to a wide area of dullness in the flanks and suggest the presence of free fluid, apart from obscuring the boundaries of any swelling of pelvic origin. Finally, encysted



FIG. 69.—Preparation of a permanent record of an abdominal tumour. The examiner by deep palpation is ascertaining the upper limits of the neoplasm.

collections of fluid sometimes give identical signs on percussion with those obtainable over abdominal neoplasms. This is particularly the case with localized, tubercular, peritoneal exudates closely applied to the abdominal wall and shut off from the rest of the abdominal cavity by matted intestine and omentum. In such instances, a dull note is produced on percussion over the central area of fluid, whilst the surrounding intestine is resonant and provides a convex, more or less rounded, margin to the dull area. Percussion should always be light at first in order to exclude as far as possible the intestinal tympany.

Auscultation is perhaps of less importance to the gynaeceologist than the methods



FIG. 70.—Preparation of a permanent record of an abdominal tumour. Tracing the boundaries of the tumour upon the skin with an indelible pencil.



FIG. 71.—Preparation of a permanent record of an abdominal tumour. Mapping out the tracing upon a sheet of frosted glass or parchment paper.

of abdominal examination detailed above. Its chief value is in the recognition

of pregnancy and the diagnosis of this condition from other abdominal swellings of doubtful nature. Appreciation of the foetal heart-sounds by means of the stethoscope is the most important diagnostic sign of pregnancy. It cannot be employed, however, before the fifth month.

Other auscultatory phenomena demonstrated by means of the stethoscope include

intestinal borborygmi, foetal movements, and uterine bruits. These, however, are not of particular value as a means of diagnosis, and require no detailed description.

The Use of Photographic or Diagrammatic Records.—For purposes of subsequent comparison, the use of photographic or diagrammatic records has much to recommend it. In the case of tumours of doubtful nature, where extended observation is practicable or desirable, such records should always be taken. By so doing it is possible to note in a graphic manner any alteration in size or shape which a swelling may have undergone between two or more examinations. The due observance of this routine will do much to eliminate errors of diagnosis, such as confusion between the pregnant uterus and a neoplasm of uterine or ovarian origin. In the preparation of such records, the boundaries of a tumour are mapped out upon a

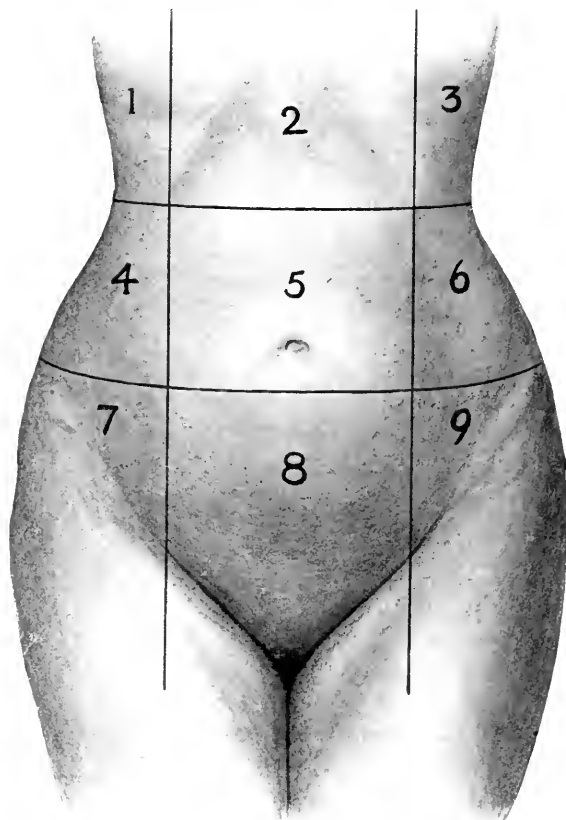


FIG. 72.—Abdominal areas.

- | | |
|-------------------------|------------------------|
| 1. Right hypochondrium. | 5. Umbilical region. |
| 2. Epigastric region. | 6. Left lumbar region. |
| 3. Left hypochondrium. | 7. Right iliac region. |
| 4. Right lumbar region. | 8. Hypogastric region. |
| 9. Left iliac region. | |

sheet of parchment paper or gauze applied to the patient's abdomen as advocated by Kelly (Figs. 69, 70, 71). Such records may subsequently be reduced to a convenient size by the aid of photography. Another method is to outline the margins of the swelling, as shown by palpation and percussion, with indelible ink or pencil previous to obtaining a photographic record. A common but less accurate method is to draw carefully upon a skeleton figure the outline of the swelling

in question. Tender areas are indicated by shading or dots, preferably in a different colour.

For the accurate description and better localization of various lesions, the abdomen has been divided into several areas and zones by means of hypothetical perpendicular and transverse planes. The vertical, or mid-Poupart planes, as their name indicates, pass through the mid point of each corresponding Poupart's ligament. The upper transverse, or subcostal planes pass across the upper abdomen on a level with the most dependent point of the lower ribs. The lower transverse, or interspinous planes pass around the abdomen through the anterior superior spines and each os innominatum. By these planes nine areas are mapped out. The three mid-line areas from above downwards are named epigastric, umbilical, and hypogastric. Each is flanked by a lateral area designated hypochondriac, lumbar, and iliac. These areas, which are familiar to all students of anatomy, are indicated in Fig. 72.

INTERNAL EXAMINATION

This comprises direct exploration of (*a*) vagina, (*b*) rectum, and (*c*) bladder by the aid of touch and vision. Vesical and rectal investigations are dealt with in later chapters and therefore only a brief reference to them is made in this section.

Vulval and Vaginal Examination.—This is used to ascertain pathological changes about the vulva, vagina, and portio vaginalis of the cervix. Direct palpation is performed by introducing one or two fingers into the vagina and palpating the structures with which they come in contact. It usually forms merely a part of the combined or bi-manual method, since with the single hand the limits of pelvic exploration are considerably restricted. In some patients, however, in whom the rigidity of the abdominal walls precludes a satisfactory bi-manual examination, and where an anaesthetic is not permissible, the simple vaginal method may be of considerable value in the diagnosis of deep pelvic lesions. Before describing in detail the points to be noted in conducting a vaginal examination, it is advisable to discuss the general technique to be observed both in the vaginal and combined methods of examination.

Preparation of the Patient.—This corresponds generally to what has already been stated in describing the preparation of a patient for abdominal examination. The points upon which emphasis is laid are the absence of any constricting bands, and the arrangement of the garments to provide free access to the parts to be examined. The clothing should be warm but light, and when possible the examination should be conducted with the patient in bed. She may wear long woollen

stockings, a nightgown, and a dressing-jacket. If the examination takes place in the consulting-room, it is usual to request that the corsets and such clothes as will interfere with the direct examination of the parts be removed. A warm dressing-gown is very useful under such circumstances. It is of course very important that the bladder and rectum should receive attention immediately before the examination takes place, since if these organs are loaded, considerable difficulty may be experienced in locating the position and nature of any abnormal swelling. Before



FIG. 73.—Dorsal position. The patient lies upon the back with the thighs abducted and partly flexed; the feet rest upon the examination table with the heels in contact.

commencing the examination, it is always well to explain to the patient exactly what is intended, and why it is necessary. Reference has already been made to those classes of patients in whom vaginal examination should not be made without having recourse to an anaesthetic. Needless to say, it is advisable for a friend or relation of the patient to be present whilst the examination is made.

Position of the Patient.—Opinion differs as to the best position in which a vaginal examination should be conducted. The preference of the author is for the dorsal position (Fig. 73). The knees are drawn up, the shoulders are slightly raised, and the heels are placed in contact. Abduction of the thighs should be as complete

as possible, and during the examination a rug is drawn over the abdomen and knees unless direct inspection of the vulva is required. If skirts are worn, care should be taken not to raise them above the knees. By taking this precaution patients object much less to the examination since there is apparently less exposure.

A word may be said as to the advisability of routine inspection of the vulva. As a general rule, this is not necessary, but in the presence of any abnormal local condition, or in inflammatory processes involving the genital tract, inspection must of course be insisted upon. If the dorsal position is employed as a routine, and



FIG. 74.—Left lateral position. The patient lies upon the left side; both thighs are flexed upon the abdomen and the buttocks are at the edge of the examination couch.

the above precautions are taken, inspection of the vulva may be performed without any objections being expressed by the patient.

By some surgeons, either the left lateral (Fig. 74) or the Sims's semi-prone position (Fig. 75) is preferred, inasmuch as they assert that there is less exposure of the person, and it is possible by this means for the examining fingers to reach higher into the pelvic cavity. In the left lateral position, the patient lies upon her left side, with both thighs flexed upon the abdomen and the buttocks at the edge of the examination couch. The position is of course the usual one for delivery in this country. It is also advisable in routine digital exploration of the rectum.

Sims's semi-prone position is really but a modification of the left lateral. The patient lies upon her left side with the buttocks at the edge of the examination couch.

The left arm is drawn under the trunk and hangs loosely over the edge of the couch. The right thigh is fully flexed and the left only partially. By this means the patient lies more completely in a semi-prone position, and consequently the vulva and vagina are raised and rendered more easy of access (see Figs. 74 and 75). The position is useful when direct inspection of the vagina is necessary, or when Sims's speculum is employed.



FIG. 75.—Sims's semi-prone position. The patient lies upon the left side with the buttocks at the edge of the examination table. The right thigh is fully flexed and the left one partially. The left arm is drawn under the trunk and hangs loosely over the edge of the couch.

Other positions are occasionally used for special conditions. Such are the Trendelenberg or Freund position, the erect or standing posture, the genupectoral (Fig. 76) or knee-elbow position, and the lithotomy position.

The Trendelenberg position is of much value in operative procedures upon the pelvic viscera, but its employment in examination is required but rarely (see Figs. 77 and 78, p. 316, Vol. III.). In this position the body is tilted so that the pelvis is raised and the head is the most dependent part. This is usually effected by means of a special arrangement on the examining couch or table, but in the absence of

such facilities a modified Trendelenberg position may be obtained by elevating the pelvis by means of firm pillows or sand-bags placed below the sacrum. When a patient is in this position, care must always be taken to prevent her slipping from the table to the floor, by placing supports below the shoulders or securing the lower extremities to the couch itself.

The erect or standing posture is only used during an examination for uterine prolapse, or to estimate the degree of general or local viscerop-tosis. It is but rarely employed by the gynaecologist, and then only to form an estimate of the

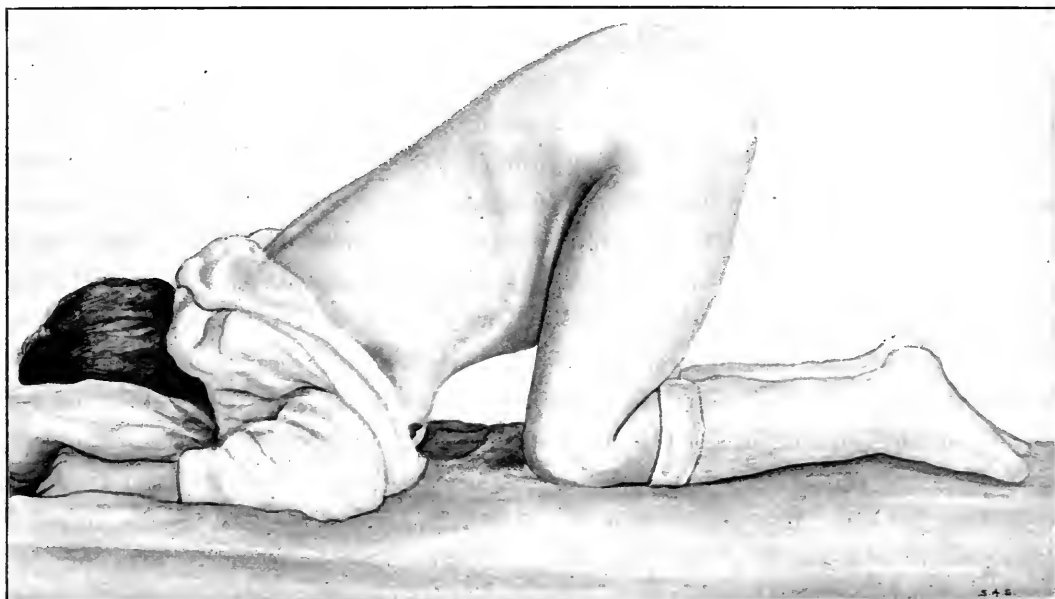


FIG. 76.—Genupectoral or knee-chest position. The patient is supported upon the knees and chest-wall. A pillow is placed below the head.

degree of uterine or vaginal prolapse which actually occurs whilst a patient is standing or walking. Some surgeons (Freund) employ the erect posture for routine bi-manual palpation of the pelvic organs. The method cannot be recommended, however, and is certainly much more uncomfortable for the patient.

The knee-chest or knee-elbow position (Fig. 76) is also only occasionally used for routine examination. The position is indicated by its title, and, it need hardly be said, is somewhat distressing to the patient. It is employed under general anaesthesia in direct cystoscopy or examination of the bladder by Kelly's method. It is also sometimes valuable in assisting to replace the retroverted gravid uterus. For ordinary purposes of diagnosis it has no particular advantage.

What has been said with reference to the knee-chest position is largely

applicable to the *lithotomy position*. It affords complete access to the pelvic organs, but owing to the extreme exposure of the patient, it is never employed without the use of a general anaesthetic. In this position the patient lies upon her back with the thighs completely flexed upon the abdomen, and the legs flexed upon the thighs. The position is usually maintained with the aid of a crutch or supports fixed to the examination table.

Preparation of the Hands.—Before any vaginal examination is made, care should be taken to cleanse the hands as thoroughly as possible. When a large number of patients have to be examined successively, as in the out-patient department of hospitals, complete sterilization of the hands between each examination is a matter of some difficulty. It is nevertheless of extreme importance, since in the absence of special precautions the transference of dangerous and virulent germs from one patient to another may easily take place through the examining fingers. For these reasons, and for the examiner's own protection, the habitual use of rubber gloves has much to recommend it. If, on the other hand, the surgeon elects to rely on the ungloved hand, a liberal use of brush, soap, and water should be made immediately before and after each examination. As an additional precaution, it is well to place the hand in methylated spirit for one minute, and in an antiseptic, such as mercuric perchloride or biniodide or weak carbolic acid, for three minutes. This somewhat tedious process should form a part of the routine, inasmuch as infection of the examining hand with the gonococcus or spirochaete of syphilis is unfortunately too common to be disregarded. The proper care of the hands, by avoiding all cracks, fissures, and septic discharges, is of the greatest importance if the examiner is also engaged in surgical work. These ends are undoubtedly best attained by the *habitual use of rubber gloves*, and the advantages are so great that they quite outweigh the slight disadvantage of diminution in tactile sensation. The latter usually disappears after sufficient experience.

If the vaginal walls are in close contact, or dry, some lubricant may be necessary, although in many cases it may be totally dispensed with. Many materials have been employed for this purpose. The commonest perhaps are liquid paraffin, glycerine, or vaseline. If this last substance is used, it should be carbolized, and contained in a collapsible tube. On no account should a single receptacle be used for the examination of more than one patient. Weak solutions of lysol, izal, or other coal tar products form very efficient lubricants, and have the advantage of being completely antiseptic. If gloves are used, such solutions are perhaps the best for general use.

The position of the surgeon during the examination depends largely upon which

hand he habitually employs for exploring the pelvis. Much can be left to personal predilection. The majority of surgeons examine the vagina by means of the right hand, and under such circumstances usually stand on the right side of the patient. If, however, the left hand is used, the examiner stands on the patient's corresponding side. Should the patient be fully anaesthetized and in the lithotomy position, the surgeon stands at the end of the examination couch, and may employ either hand with equal facility. It is well, if possible, to be ambidextrous, especially during the examination of patients at their own homes, where it is sometimes necessary to use the left hand in order to avoid moving the patient.

A question sometimes arises relative to the advisability of employing one or two fingers during vaginal examination. Whenever possible two fingers (index and medius) should be used, since owing to the extra length of the medius it is possible to reach higher in the pelvis than with the index finger alone. It is also much easier to appreciate the size of any abnormal swelling owing to the increased area of the palpating surface. The consistency of the tumour and the existence of fluctuation are likewise more readily appreciated. Finally, if the points of the two fingers are separated, it is possible to explore two different parts at the same time. Nevertheless two fingers are not permissible on every occasion. In the case of nulliparae, for example, the vagina is sometimes so narrow that the index finger alone can be employed. The use of one finger is certainly more comfortable to the patient, since the distension of the passage is less. If care and gentleness are exercised, however, it is often possible to overcome the resistance. The increased information so obtained more than compensates for the little extra difficulty and discomfort. On the other hand, if the hymen is intact, or if much pain is produced owing to spasm or contraction, the surgeon is compelled to limit his exploration accordingly.

Examination under General Anaesthesia.—Many of the difficulties that arise in the course of gynaecological examination are caused by muscular contraction and rigidity on the part of the patient. Some reference to this important factor has already been made when discussing abdominal examination. It is of equal importance in the case of investigations conducted *per vaginam* and particularly in the combined or bi-manual method. In patients who are extremely nervous, a satisfactory examination is rarely possible. Under such circumstances, the greatest assistance may be obtained by the employment of general anaesthesia. The same applies in the case of young unmarried women in whom a pelvic lesion requiring treatment is suspected. With the complete muscular relaxation afforded by anaesthesia a very thorough examination of the pelvic organs is possible owing to

the greater pressure that can be exerted under these circumstances. A note of warning should be sounded in this connection, inasmuch as if undue force is exerted serious damage may be done to the underlying viscera; thus adhesions may be broken down, and pus-containing cavities or cysts ruptured. Cases have indeed been recorded in which rupture of viscera occurred during examination under anaesthesia which led to a fatal termination.

As to the agent to be used in those cases where general narcosis is indicated, it is generally advisable to employ chloroform or ether, or a mixture of these substances. The anaesthesia produced by nitrous oxide or ethyl chloride is usually of too short duration for an examination to be completed. Muscular relaxation also is not so thorough as when ether or chloroform is used. Whatever narcotic is employed, the examination should not be commenced until anaesthesia is complete. Many of the fatalities that have occurred are due rather to reflex action than to the anaesthetic itself. It may be noted, for example, that cases are on record where fatal inhibition of the heart has followed the passage of a uterine sound apart from any question of anaesthesia. In those instances where a general anaesthetic is undesirable, and yet a certain amount of narcosis is necessary for complete pelvic examination, sufficient relaxation of the muscles may be produced by the administration of morphia and alcohol half an hour before the time fixed for the examination. Whenever general anaesthesia is required, arrangements should be made to follow the examination by any operative procedure that may be necessary. Further, if any doubt exists as to the nature or extent of a particular lesion, it is always an excellent plan to examine the pelvic viscera whilst the patient is under general anaesthesia before any operative procedures are undertaken. A much clearer insight may thus be gained into the condition that is present. For example, in the case of complicated tumours the boundaries are readily demonstrated, and in swellings of doubtful nature the diagnosis rendered evident. In carcinoma of the uterus, an examination under general anaesthesia is of particular value in ascertaining the extent of the growth and the possibilities for radical operation. In fact it may be stated that if in all doubtful and difficult cases the patient is given the advantage of an examination under anaesthesia serious mistakes can be avoided, and in some cases unnecessary operations prevented.

The Value of Gynaecological Chairs and Tables.—For purposes of vaginal examination some surgeons prefer to place the patient upon a specially adapted chair or table. Although such chairs are in use in certain American and Continental clinics, they have not been received with much favour in this country. In the first place they are a source of alarm to patients, and anything which tends to increase nervousness

or discomfort renders examination more difficult, and is therefore to be avoided. Objects which are liable to cause alarm to patients should always be carefully hidden, and for these reasons the English consulting-rooms offer many advantages over the American offices. Examining chairs are usually constructed to allow the patient's position to be rapidly altered. Relaxation of the abdominal muscles is effected by raising the shoulders and pelvis and so approximating the lower ribs and the upper border of the pelvis. The thighs are flexed at the hip joint and kept in position by adjustable leg supports with straps. The table is also adapted to allow of the administration of vaginal douches and so forth. If general anaesthesia is employed, these examining couches possess certain advantages, but inasmuch as in this country anaesthesia is usually employed as a preliminary to operation a proper operation table is preferred by most surgeons.

The Technique of Vaginal Examination.—As a preliminary to vaginal examination, inspection of the external genitalia is called for under certain circumstances. Amongst the indications may be mentioned :

(a) The presence of any complaint directly referred by the patient to the vulva or perineum.

(b) Inflammatory conditions, acute or chronic, involving the genital tract.

(c) When much pain appears to be produced by simple digital vaginal examination.

(d) When symptoms point to the condition of retained menses.

(e) If the patient complains of dyspareunia.

Inspection should be systematic and the condition of all parts of the vulva, perineum, and anus studied. Particular note should be made of any unusual swelling of the parts, the presence of abnormal pigmentation, excoriation, fissures, rashes, and ulceration. The character of any discharge about the vulva must receive attention, and the condition of the introitus vaginae, perineum, and anal margins examined.

The external investigation of the parts completed, the examiner introduces one or two fingers into the vaginal canal and directly palpates the parts. If two fingers are employed, the index should be introduced first, the thumb being employed to separate the labia minora. Special care must be taken to avoid the clitoris, vestibule, and urethral meatus. After introduction, the hand is rotated to bring the palmar surface of the exploring fingers into direct contact with the anterior vaginal wall. The remaining fingers are folded into the palm of the hand or placed beneath the buttocks. The condition of the vaginal walls should be carefully noted, particularly with regard to length, abnormal swellings, local tenderness,

consistency, and temperature. Thus, in the case of acute inflammatory lesions attacking the vagina, the walls appear velvety to the touch ; there is usually extreme tenderness and the local temperature is raised. On the other hand, in a patient who has been accustomed to employ vaginal douching over a long period, the mucous membrane frequently appears hard, thick, and dry, and may be devoid of all tactile sense. Attention is next paid to the vaginal portion of the cervix. Its direction is ascertained, the consistency of its tissues noted, along with the presence of any irregularities, fissures, or swelling. With the patient in the dorsal position, the normal axis to the cervix points downwards and backwards. This direction is modified in the case of uterine displacements. The margins of the os externum are palpated and a note made as to whether the orifice is circular, transverse, or fissured. If severe lacerations are present, the amount of eversion of the lips of the cervix must be estimated, and the presence of any erosion appreciated. Examination should also be made for any hardness or induration, not only in the tissues of the cervix itself but also in the structures in immediate relation to the vagina. Thus, a parametric deposit may surround the cervix and extend to the submucous tissues along the anterior or posterior vaginal wall, giving rise to an induration of cartilaginous consistence. One or two points concerning palpation of the cervix require special mention. During pregnancy the softening of the tissues may be so extreme that to the inexperienced the structure appears to be absent. During the month immediately preceding delivery, the os externum is usually dilated and will admit the tip of the index finger. In elderly patients, on the other hand, atrophy of the tissues occurs, and the os externum often appears flush with the vaginal vault. If atrophy of the vaginal walls has occurred, care must be taken not to mistake the aperture produced by a band of localized constriction for the os externum.

THE COMBINED EXAMINATION

By combined examination is usually meant direct palpation of the pelvic organs through the vagina and through the abdominal wall by means of the examiner's two hands. It should, however, include also examination by the recto-abdominal and recto-vaginal methods.

A. The Bi-manual Method.—The bi-manual or combined abdomino-vaginal method is the most valuable means at the surgeon's disposal for exploring the condition of the pelvic viscera in the female, and forms the basis of by far the greater part of gynaecological diagnosis. It really constitutes an extension of the vaginal examination previously described, and is so important that it should never be omitted

whenever simple vaginal exploration is permissible. Having completed his investigation of the vagina and vaginal cervix, according to the details supplied above, the surgeon places his other hand upon the patient's abdomen (Fig. 77). If muscular relaxation is complete, he then directly palpates, between the internal and external examining hands, the pelvic viscera in turn. This investigation should be systematic, commencing with the uterus, then passing to one set of appendages, to be followed



FIG. 77.—Bi-manual examination with the patient in the dorsal position. The index and middle fingers of the right hand are introduced into the vagina whilst the left hand is placed upon the abdominal wall, above the pubes. The surgeon stands at the side of the couch.

by the other, and finally exploring the structures in direct relation with these viscera, viz. parametrium, bladder, ureters, and rectum.

The uterus is best palpated by placing the index finger of the internal hand in the anterior vaginal fornix, whilst the middle finger abuts against the vaginal cervix or posterior vaginal vault. The external hand is placed upon the abdominal wall about $1\frac{1}{2}$ inches above the symphysis pubis with the finger-tips directed towards the umbilicus (Fig. 78). Gentle sustained pressure should then be made by the external hand without moving the internal, when the organ becomes directly palpable

between the two hands. The uterus is felt by the sense of resistance, and if it is absent the fingers of the two examining hands come into contact. If similar palpation is made in different directions, the size and shape of the organ can be estimated. The points to which special emphasis should be directed are variations from the normal in shape, consistency, size, and mobility. In health the organ is extremely movable, and can easily be displaced forwards, or backwards into the hollow of the sacrum. Lateral movement is also possible, and if upward pressure



FIG. 78.—Bi-manual examination with the patient in the lithotomy position. The surgeon stands at the foot of the examination couch and the fingers of the external hand are directed towards the umbilicus.

is exerted by the internal hand, the fundus may be raised to a point almost midway between the umbilicus and symphysis pubis. Such movement as a rule does not cause pain, but is best appreciated when the patient is under complete anaesthesia owing to the greater muscular relaxation so produced.

The uterine ligaments are not easily palpable unless the seat of some pathological lesion. Thus, the broad ligaments cannot be appreciated bi-manually unless they are thickened or indurated by inflammatory deposits or neoplasms. The round ligaments also are not easily felt unless the uterus forms a tumour, physiological or otherwise, above the pelvic brim. Under these circumstances, if the abdominal tissues

are not thick, and muscular relaxation is complete, the ligaments may sometimes be felt by placing the external hand upon the lateral aspect of the uterus in a position vertical to the uterine direction. The utero-sacral ligaments are best palpated per rectum, and to this point reference will be made subsequently.

After completing the palpation of the uterus, the examiner next proceeds to explore the *ovaries*. These organs can be felt bi-manually by exerting upward and outward pressure by the internal hand in the corresponding vaginal vault whilst downward sustained pressure is made by the external hand. The ovary is felt as an oval body. The pressure exerted upon the ovary by the examining hand often gives rise to some pain or discomfort on the part of the patient, which may be associated with the sensation of nausea. The organs are normally very movable—a point of some value in recognizing them. If they are not felt in their usual position, an attempt may be made to find them by following the line of the corresponding Fallopian tube from each uterine cornu. Care should be taken not to mistake scybala for the organs in question. This is particularly prone to occur in the case of the left ovary owing to its close relation with the pelvic colon. The points to be noted with regard to each organ are the degree of mobility, its shape, size, and any irregularities on its surface.

The Fallopian tubes can only be palpated with difficulty unless they are enlarged by disease. In health, their consistency is so soft that it is practically impossible to define their limits. The structure often felt and diagnosed as a Fallopian tube is a corresponding round ligament. This is about the same size, follows somewhat the same course, and is more readily appreciated. When the tube is enlarged, by inflammation or otherwise, it is readily palpable by the bi-manual method, and forms an oval swelling, frequently fixed and tender, situated in the corresponding posterior quadrant of the pelvis. If it forms a tumour of any size, an attempt should be made to elicit the sense of fluctuation between the external and internal examining hands. This remark refers also to cystic ovarian tumours.

Having explored the genital organs themselves, the examiner must not complete his bi-manual examination without noting any abnormalities with respect to the adjacent viscera. Thus, the bladder, ureters, and rectum must all receive attention.

The urinary bladder is usually so soft that, when empty, its palpation bi-manually is impossible. When full, however, it produces a bulging of the anterior vaginal wall, and may easily be felt as an elastic fluctuating tumour in front of the uterus and extending above the symphysis pubis. It naturally forms a bar to bi-manual exploration of the underlying viscera, and therefore the viscus should always be empty when a complete pelvic examination is contemplated. When extending

above the symphysis pubis, the bladder has been known to give the impression to the examiner of a cystic tumour.

The ureters, unless the seat of some abnormality, are not easily recognized by abdominal palpation. The only accessible portion of the tube is the terminal inch, which is in relation with the anterior vaginal fornix just above the point at which it enters the bladder. It is said by some authors that each ureter can be felt in this position as a smooth movable cord, which disappears as it passes upwards. When its tissues are thickened by disease, or a calculus is lodged at its terminal portion, the tube is much more easily recognized.

What has been stated with regard to the ureter refers in great measure also to the lymphatics and blood-vessels. As a rule the pelvic lymphatic glands are not palpable unless they are considerably enlarged. Under deep anaesthesia they may then occasionally be felt by combined recto-abdominal pressure. The lumbar glands cannot be recognized unless their size is much increased. Of the vessels supplying the pelvic viscera, the arteries as a rule cannot be directly palpated, but pulsations communicated to the adjacent tissues are readily perceptible upon vaginal examination. The pulsation in the larger branches in relation with the pelvic wall can also be recognized per rectum. Veins, on the other hand, cannot be felt unless they are the seat of thrombosis, or contain phleboliths.

It need hardly be said that in order to obtain the full value of bi-manual examination, considerable practice and experience are necessary. The beginner frequently has difficulty in recognizing the normal structures that intervene between his hands, and is unable to locate the position of abnormal swellings or any induration that may be present. This knowledge can only be gained as the result of continual practice, augmented by the aid afforded by operations, and the opportunity of observing the condition of organs previously explored by the sense of touch.

B. Tri-manual Method of Examination.—For the investigation of tumours of doubtful nature, and particularly the detection of small collections of fluid within the pelvis, Winter has devised a method of tri-manual percussion. The method consists in palpating the swelling between the external and internal examining hands as in the ordinary bi-manual procedure. Sufficient pressure should be made to fix the abnormal mass and prevent it slipping from between the grasp. An assistant then percusses the fingers of the external hand. If fluid is present, a quick fluctuating wave is conveyed from the external to the internal hand. If the tumour happens to be deeply seated, and the surface is obscured by intestine or omentum, it is practically impossible to recognize its fluid contents without having recourse to this method (see Fig. 79).

C. Rectal Examination.—Rectal examination is necessary to explore the pelvic viscera when vaginal methods are not permissible owing to imperforate, contracted, or painful hymen, or an extreme degree of vaginismus. It is also employed in the pelvic exploration of unmarried women when resort is not made to anaesthesia. In itself it is of use in exploring the recto-vaginal septum, Douglas' pouch, the utero-sacral ligaments, and the posterior extensions of the parametrium. As regards the last mentioned, rectal examination is of extreme value in the diagnosis



FIG. 79.—Tri-manual method. The surgeon's hands are placed in the bi-manual position whilst an assistant percusses the fingers of the external or abdominal hand.

of malignant and inflammatory disease, since it affords direct evidence of the extension of the lesion. It should also be used to ascertain and especially to diagnose the exact orientation of all swellings in the posterior part of the pelvis, and whether a swelling of obscure nature is in relation with the recto-vaginal septum or uterus.

For simple rectal examination, the patient may be placed in the left lateral or in the Sims's semi-prone position. If, however, the combined recto-abdominal (Figs. 80 and 81) or the recto-abdomino-vaginal method is to be employed (Fig. 82), the patient should be placed in the dorsal or, better still, the lithotomy position.

Previous to the examination, the rectum should be completely emptied by enema. As a rule, one finger is sufficient for ordinary exploratory purposes. In those cases, however, where disease is situated in the upper portion of the rectum, it may be necessary to introduce the index and middle fingers into the canal. It is never requisite to employ a greater number of fingers or the entire hand as has been suggested by Simon. The examining fingers should be protected by a rubber glove or finger cots, and well lubricated with some non-irritating material, the greatest



FIG. 80.—Recto-abdominal examination. The patient is placed in the lithotomy position. The surgeon's right index finger is introduced into the rectum, whilst the fingers of his left hand exert pressure upon the abdominal wall immediately above the pubes.

care being exercised during the whole examination to prevent the production of any fissure or abrasion of the rectal mucosa. As a general rule, the rectal walls are in contact. They are separated by the examining fingers, and care must be taken to avoid the folds of mucous membrane. If the uterus is in its normal position, the vaginal portion of the cervix is felt through the anterior rectal wall as a distinct rounded prominence. If, on the other hand, the uterus is displaced backwards, this protrusion is absent, and the swelling produced by the corpus uteri is palpable. In some cases it may be difficult to find the lumen of the canal. In such a

contingency, Sellheim has recommended that the gut be distended with water before examination takes place. During the course of the examination, note must be made of the presence of any fissure or haemorrhoidal condition about the anal margins. As the finger passes through the anal sphincter, the tone of the muscle should be ascertained, and the presence of any laceration, localized or diffuse growth, or contraction of the lumen appreciated.

The examination of the rectal wall itself being completed, palpation of the



FIG. 81.—Recto-abdominal examination. The uterus is being displaced downwards by traction upon the cervix to permit of its more direct palpation between the external and internal fingers.

uterus and its appendages should be attempted. Reference has been made to the ease with which the cervix, when in its normal position, can be felt. For the better exploration of the genital tract, it is usual to employ the combined recto-abdominal method. In essential details and technique it is identical with the combined vagino-abdominal method, and further reference is therefore unnecessary.

For some purposes the combined recto-vaginal method possesses advantages (Fig. 82). It is, for example, useful in the investigation of tumours felt through the rectal wall and in relation with the recto-vaginal septum, since the topography of

such swellings can be determined with much greater ease by the method. The technique employed is to introduce the middle finger of the right hand into the rectum and the corresponding index finger into the vagina (see Fig. 82). If, on the other hand, two fingers are employed for exploration of the rectum, the thumb must be used for palpation of the vagina. If the external hand is used to palpate the pelvic organs from above, the method is known as the combined recto-abdomino-vaginal, and possesses certain advantages over the simple abdomino-vaginal method. Upon with-



FIG. 82.—Recto-abdomino-vaginal examination. The index and middle fingers of one hand are introduced into the vagina and rectum respectively whilst the fingers of the other hand apply pressure upon the abdominal wall. The pelvic organs are palpated between the two hands.

drawing the fingers, special note must be made as to the characters of any discharge resulting from the examination, particularly as to the occurrence of haemorrhage. When it is desired to investigate the rectal wall in greater detail, some form of speculum is necessary. A common type of tubular rectal speculum is shown in use in Fig. 83.

D. Vesical Examination.—Exploration of the bladder and urinary tract is of considerable importance in the investigation of disease referred by the patient to the genital tract. The whole question will be discussed at length in a later chapter,¹

¹ Article on Methods of Examination of the Urethra and Bladder (Vol. III. p. 123).

and therefore nothing more than a brief reference is here required. It is very rarely necessary to palpate the genital organs directly through the bladder, although such examination is by no means difficult, owing to the shortness and dilatability of the female urethra. Such an investigation may be necessary in the case of obscure tumours in relation with the anterior vaginal wall or anterior parametrium. Thus, in the diagnosis of cysts in connection with the anterior vaginal wall, the finger or a sound may be introduced into the bladder in order to



FIG. 83.—Rectal examination by means of a tubular speculum.

distinguish the lesion from simple prolapse or cystocele. For the diagnosis of conditions affecting the bladder wall, or in close relationship with the same, cystoscopy is a more thorough and scientific method of investigation than simple palpation. If it is desired, however, to introduce the finger into the bladder, the urethra must first be distended by a series of graduated dilators, or the cone-shaped instrument devised by Kelly. Special care must be taken to avoid the introduction of bacteria, since a certain amount of laceration of the urethral mucous membrane is almost invariably produced.

AIDS TO PHYSICAL EXAMINATION

For the more thorough examination of diseases affecting the genital tract recourse is made to certain accessory methods of diagnosis. These include the following: (1) Instrumental examination; (2) macroscopical and microscopical examination of tissues; (3) bacteriological examination; (4) the investigation of discharges from the genital tract, menstrual and otherwise; (5) examination of the blood; (6) radiography.

Instrumental Examination.

The instruments used by the surgeon in the course of gynaecological examination are devised principally to permit a more detailed investigation of those

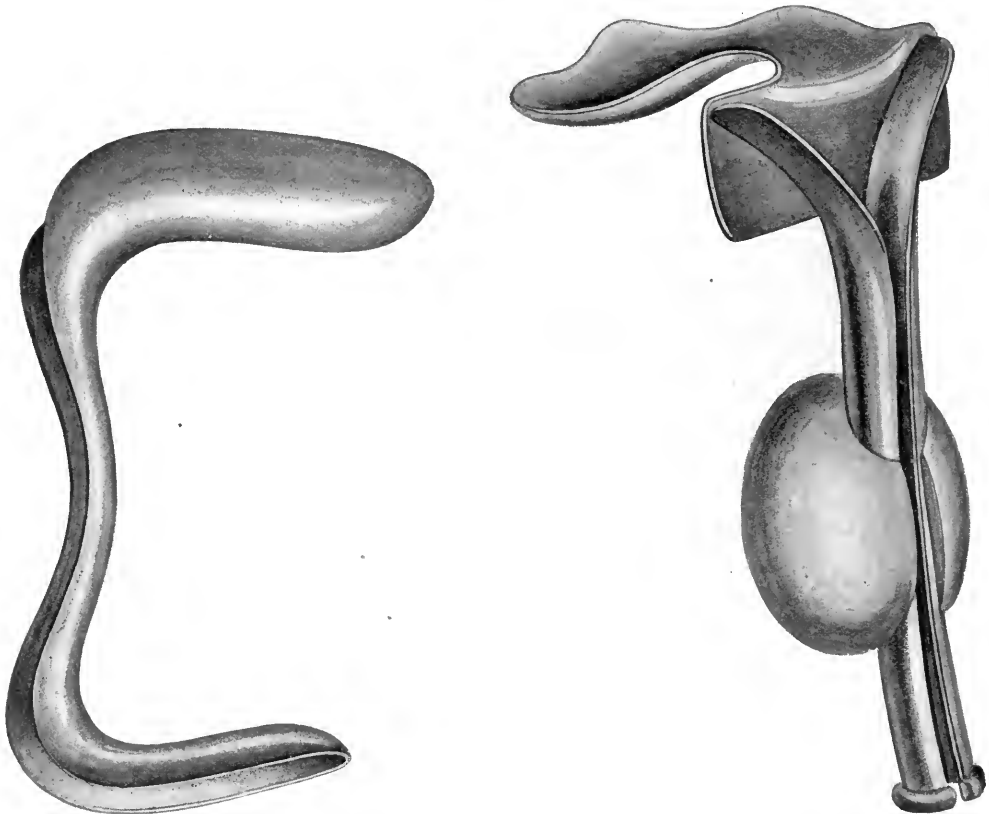


FIG. 84.—(a) Sims's duck-bill speculum.

(b) Auvard's speculum.

parts which normally can only be explored by palpation. Under this heading are included the various vaginal specula, volsellae, tenacula, the uterine sound, and instruments for dilatation of the cervical canal and exploration of the uterine cavity.

Specula.—The use of specula is to separate the vaginal walls and permit of direct inspection of the vaginal portion of the cervix and the walls of the vagina itself. Many instruments have been devised for this purpose. They may, however, be divided broadly into two groups, viz. (a) specula composed of one or more blades, and (b) tubular specula.

(a) *The 'bladed' specula* are essentially retractors and their use is to separate the two vaginal walls. When the introitus vaginae is opened by means of such



FIG. 85.—Introduction of Sims's speculum. The patient lies in the semi-prone position. The blade of the instrument is introduced in the long axis of the vulva, the index finger of the surgeon occupying the cavity of the speculum.

a speculum, and the anterior or posterior vaginal wall well retracted, the passage becomes ballooned with air, affording the surgeon a very complete view of the vaginal fornices, cervix uteri, and opposite vaginal wall. The instrument which may be taken as a type of this speculum, and which is most widely used, is that devised by Sims. *The Sims's or duck-bill speculum* (Fig. 84(a)) consists of two concave spatulate blades of different size, connected by an intervening handle, thus providing two specula of different dimensions. To use this instrument for ordinary purposes of diagnosis, the patient is usually placed in Sims's semi-prone

position. The speculum, previously sterilized, is lubricated, if necessary, upon the convex aspect of the blade. It is then taken in the right hand, the index finger being placed along the concavity of the blade. The labia are separated with the fingers of the left hand, and the blade is then introduced with the concave surface uppermost. As it advances along the vaginal canal, it is rotated until the convex surface is directly in contact with the posterior vaginal wall. If traction is now exerted in a downward and backward direction by means



FIG. 86.—Sims's speculum in position. Traction upon the posterior vaginal wall and perineum is exerted by the surgeon whilst an assistant raises the right buttock.

of the other blade which is used as a handle, air enters the vagina, and the cervix is easily brought into view. If traction is exerted in too backward a direction, the internal blade tends to slip in front of the cervix and so obscures this structure. This is prevented by increasing the downward pull. There is usually a tendency for the patient's right or upper buttock to fold over the vaginal introitus and interfere with direct vision. This may be obviated by an assistant raising the buttock in question with his hand. The mode of introduction of the speculum and its position when in use are shown in Figs. 85 and 86. Not uncommonly the

retractor is introduced too deeply. This is a mistake, inasmuch as it pulls upon the attachments of the cervix and tends to displace this structure. At times, also, the anterior vaginal wall bulges unduly into the passage and obstructs the view of the parts above. If this is the case, it should be pressed forward with an anterior blade or spatula. The speculum may also be employed when the patient is placed in the lithotomy position, as shown in Fig. 87. This, in fact, is the usual procedure when any operation is contemplated upon the cervix or uterine body by the vaginal route. The mode of introduction of the speculum in this position is in essential



FIG. 87.—Application of Sims's speculum with the patient in the lithotomy position. Traction is exerted by the instrument in a downward direction whilst the cervix is seized and steadied by a volsella.

details the same, care being taken to introduce the broad diameter of the blade in the long axis of the vulva to avoid the production of any laceration of the vulval mucosa. Many modifications of this instrument have been devised by different surgeons. The most important are those of Simon, Auvard, Pozzi, and Doyen.

Simon's speculum consists of two separate blades, each mounted on a solid slightly curved handle. The posterior blade is concave, whilst the anterior is flat. In the case of the latter, the curve of the handle is more accentuated in order to avoid the prominence due to the symphysis pubis. The speculum is made in various sizes, but in all cases care should be taken to see that the blades are sufficiently

long. To use the instrument, the patient is placed in the dorsal or lithotomy position at the extreme edge of the examining couch. The posterior blade is passed first as with the Sims's instrument. The handle is then seized by the left hand and marked traction exerted in a downward direction. It should be noted that retraction of the perineum to an extreme degree may be produced without causing any undue pain or discomfort. The handle of the anterior or upper blade is then passed in a similar manner, care being taken to introduce the blade immediately below the urinary meatus. The two blades are separated as widely as possible, and if no general anaesthesia is used, precautions must be taken to avoid nipping the vaginal or vulval mucous membrane between the margins of the specula. In removing the instrument the anterior blade is withdrawn first.

Auvard's speculum (Fig. 84(b)) has some advantages over other types, but can only be employed in the lithotomy position. It is chiefly used when exploration or small operative procedures have to be carried out by the vaginal route without the aid of skilled assistance. The instrument consists of a broad posterior vaginal blade, with a solid grooved handle weighted by a heavy rounded mass of lead situated about its centre. This increased weight of the handle takes the place of the downward traction usually exerted by the assistant, and so maintains the instrument in position. The groove in both blade and handle is to permit the escape of fluid used for douching purposes.

Pozzi's specula are essentially retractors for the vaginal walls and are of considerable value when it is necessary to expose fully the vaginal fornices and cervix. An assistant is necessary since four separate blades have to be introduced and held in position, the two lateral retractors being short broad blades. The anterior and posterior, on the other hand, are long and narrow.

The view obtained with any of these specula is very satisfactory, particularly if good illumination is secured by the aid of one of the many excellent electric mirrors now placed on the market. The only objection to their use is that with the exception of Auvard's instrument, an assistant is necessary if any manipulations are to be conducted whilst the speculum is in place. In the case of the ordinary Sims's duck-bill speculum, Hubert Roberts has devised a useful modification to obviate the services of an assistant in elevating the upper buttock by attaching a curved metal flange to the upper border of the handle. Specula of this nature undoubtedly give the best view of the cervix and are to be preferred to the tubular varieties.

Bi-valve and tri-valve specula are employed by some surgeons, particularly in the United States, although in this country they have not up to the present been received with so much favour as abroad. A very useful type is shown in Fig. 88. These

double- or treble-bladed instruments are hinged at the external extremity and provided with a screw-and-ratchet arrangement which permits of separation of the distal extremity with very little movement at the proximal end. The value of such a speculum lies in the fact that its introduction causes no pain, whilst the separation of the distal extremities of the blades displaces the vaginal walls at their point of greatest dilatability without causing undue distension at the narrow and tender introitus. The speculum, whether it be bi-valve or tri-valve, is always introduced closed, with the blades lying laterally at the vaginal entrance. The instrument is then rotated to bring the blades directly anterior and posterior. The speculum is opened by turning the external screw. A very excellent view is secured of the vaginal vault, but the instrument is somewhat complicated,

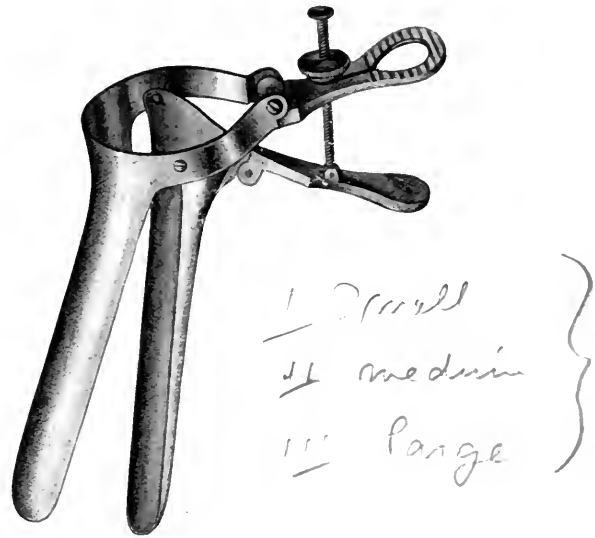


FIG. 88.—A type of bi-valve speculum.



FIG. 89.—Introduction of a bi-valve speculum. The blades are in apposition and the instrument is introduced in the long axis of the vulval introitus to avoid laceration of the mucosa.

and the hinges and screw are liable to get out of order. These facts perhaps

militate against its more general use. Of the two types the tri-valve is the better. The instrument may be partially withdrawn with the blades still open in order to bring into view the vaginal walls. No assistant is of course necessary with either of these instruments. The mode of using a bi-valve speculum is shown in Figs. 89 and 90.

(b) *Tubular Specula*.—Vaginal specula of cylindrical shape are perhaps in less general use to-day for purposes of routine gynaecological examination than



FIG. 90.—A bi-valve speculum in position. The instrument has been rotated within the vagina before the blades are separated.

was the case some years ago. This is undoubtedly owing to the much better access afforded by the blade or retractor type of instrument. Tubular specula, however, have their special advantages, and on certain occasions are to be preferred. This is so when local applications of strong caustics are to be made to the cervix as in the case of cervical erosions, catarrh, etc., to prevent the fluid from coming into contact with the vaginal walls. The most widely used speculum of this nature is that originally devised by *Ferguson*. The instrument is tubular, with the outer extremity trumpet-shaped and the inner bevelled. The posterior wall is longer than the anterior for anatomical reasons and ease of introduction. The speculum

is made in three to four sizes, these being 'nested' for the sake of portability (Fig. 91). It is made of various materials, including plated metal, silvered glass, and vulcanite. Metal appears to be the most generally useful, inasmuch as it can be sterilized by heat, is unbreakable, and can be easily replated when required. A possible disadvantage to metal is its sharp edge, which may cause damage to the vaginal mucosa unless care is used in the mode of its introduction. This may be prevented in the case of glass by using a speculum with thick walls. At the same time glass has the disadvantage of being easily broken, and serious accidents may occur through its use. Vulcanite specula cannot be heated and require sterilization

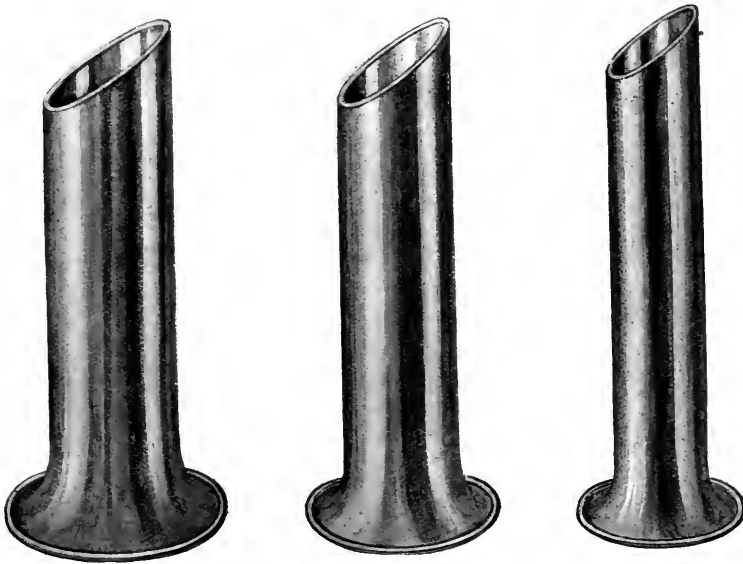


FIG. 91.—Ferguson's tubular specula.

in antiseptic solutions. They are neither as clean in use, nor as durable, as metal instruments. Whatever type is employed, the inner aspect of the instrument should reflect the light in order to illuminate the upper recesses of the vagina. This is easily effected by plating in the case of metal instruments and by silvering if glass is used. It should be noted, occasionally, that clear tubular glass specula are employed, their use being to afford direct inspection of the vaginal walls. A false impression of the condition present is, however, liable to be obtained, owing to the fact that the uniform distension of the passage by the speculum disguises the appearance of the tissues, by stretching the walls and altering the vascular supply. For this reason a much better opinion can be formed by noting the condition of the vaginal mucosa as the speculum is withdrawn.

For introducing Ferguson's speculum, the patient may be in either the dorsal

or lateral position. The instrument is lubricated on its outer surface and, after the labia have been separated by the fingers of the left hand, is gently passed into the vaginal canal. As the instrument passes the introitus, the long posterior wall must be in contact with the perineum, and the short anterior wall in front, in order to

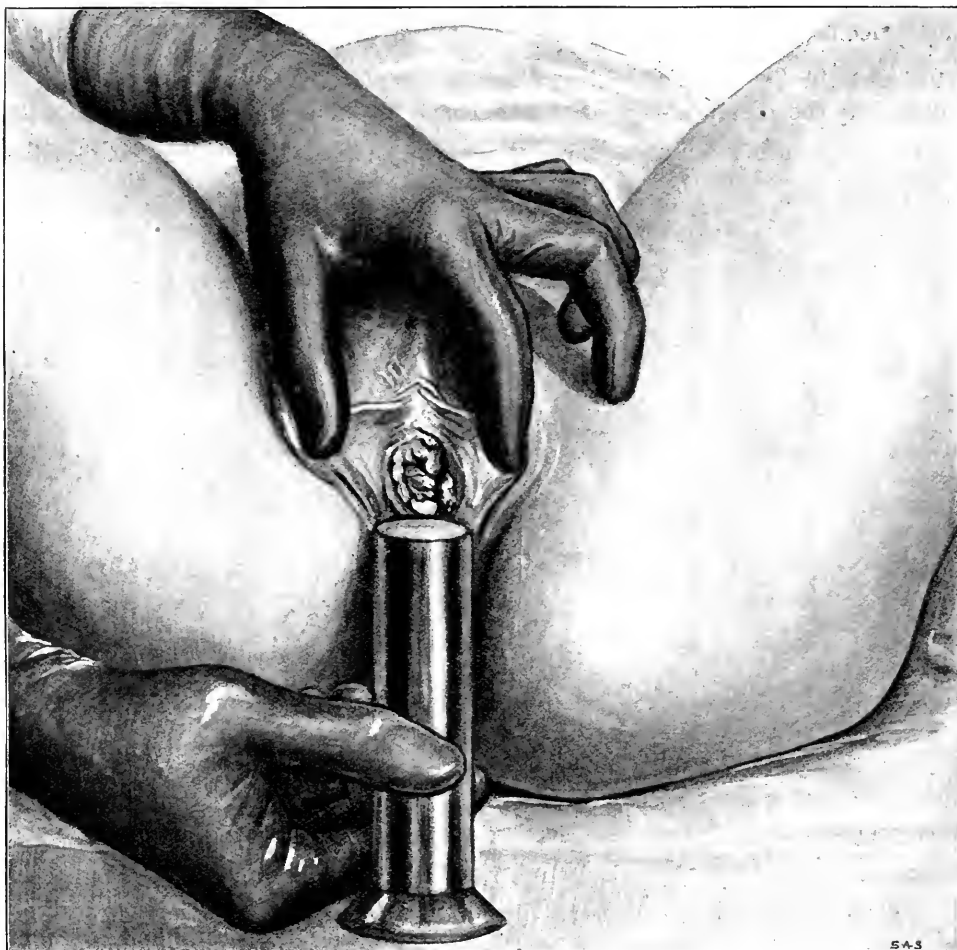


FIG. 92.—Introduction of Ferguson's speculum. The long posterior wall of the instrument is in relation with the perineum, whilst the anterior is bevelled to avoid contact with the urethral orifice and vestibule.

avoid contact with the tender vestibule and urethra (Fig. 92). Once the introitus has been passed, the speculum may be gently rotated until it reaches the vaginal vault when the longer wall should again be posterior. If the cervix is not seen at once protruding through the upper open end of the instrument, careful manipulation will soon bring it into view (Fig. 93). It should be noted that, as usually introduced, the anterior lip of the cervix first enters the open end of the speculum. This may give

the impression of hypertrophy of the anterior lip unless the instrument is depressed and the posterior lip exposed. Occasionally, in the case of an adherent cervix, some difficulty may be experienced in exposing the os externum. It is well in such a contingency to trace upwards the vaginal wall until the smooth mucosa of the vaginal cervix is recognized. The speculum should not be too long or inserted too far, since by so doing an artificial ectropion of the cervical canal may be produced. An electric head light is often of the greatest use in exploring visually the vaginal



FIG. 93.—Ferguson's speculum in position, exposing the vaginal portion of the cervix.

vault and cervix through a tubular speculum. One advantage of Ferguson's instrument is the fact that it can be used without the services of an assistant, and applications can be made to the cervix without the risk of infection from the vaginal walls. On the whole, however, it does not give as good a view of the cervix as the bladed specula, and it certainly tends to obscure fissures and lacerations. It will readily be understood also that the rigidity of the tube may give rise to considerable difficulty in the performance of various manipulations in the region of the cervix. When direct inspection is necessary in the case of young unmarried patients, Kelly recommends the use of a tubular speculum to which is attached a handle, such as

is employed in his method of direct cystoscopy. The patient is placed in the knee-chest posture to facilitate ballooning of the vagina with air when the speculum is introduced. An instrument 2 cm. in diameter is recommended by Kelly for routine vaginal examination, but in the case of virgins one only 10 or 12 mm. will allow complete inspection of the whole of the vagina. With such a speculum no injury to the hymen need be anticipated. A handled tubular speculum in use, with the patient in the lithotomy position, is shown in Fig. 94.



FIG. 94.—A type of tubular speculum with handle, in position for exposing the vaginal cervix.

Volsella and Tenaculum.—These instruments are so frequently employed in conjunction with various specula that their use may be considered in this section. The volsella (Fig. 95) consists of a pair of toothed forceps with long shanks and scissors-like handles provided with a catch for fixation. Many different types are sold by the instrument makers, and hardly a year passes by without some addition being made to the number already existing. The chief use of the instrument is to seize and steady the cervix uteri, and, by drawing the uterus downwards towards the vaginal outlet, render the parts more accessible to inspection and touch. The numerous forms of volsella have been devised with the aim of improving the grip

of the instrument upon the tissues without producing laceration or any undue pain to the patient. They may be divided broadly into two groups—those with sharp teeth and those with blunt teeth. The former directly perforate the tissues with

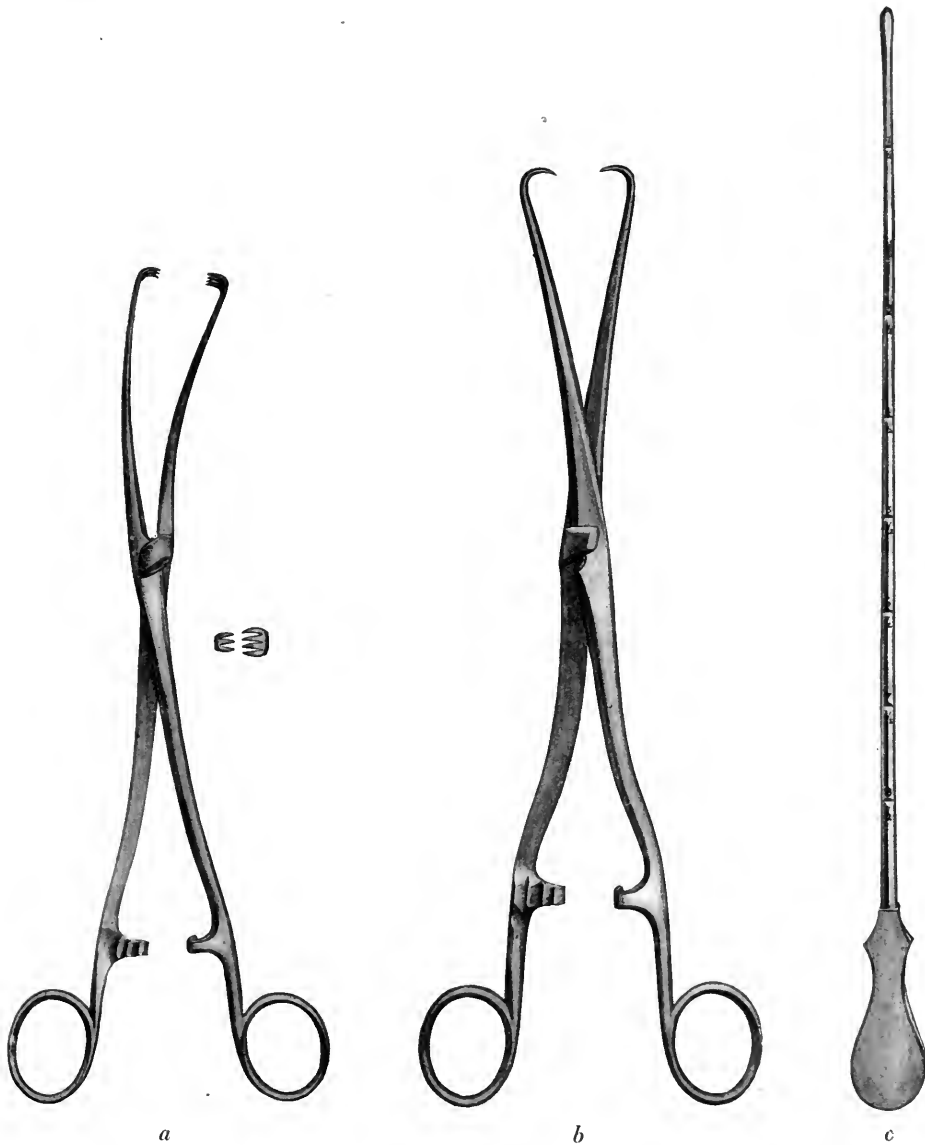


FIG. 95.—*a*, Volsella with multiple teeth ; *b*, with single teeth. *c*, Uterine sound.

which they come in contact, whilst the latter maintain their grip by firm pressure alone. Volsellae with sharp teeth are preferred by most gynaecologists since they secure a firmer hold and appear to cause less discomfort to the patient. At the same time care must be exercised in applying the instrument to avoid contact of

the sharp points with the examiner's fingers or the mucous membrane of the vagina. It is an undoubted fact that the majority of volsellae in general use do not long stand the ordinary daily wear and tear and quickly deteriorate. After many applications, the points tend to become separated and the joints loose. Such instruments are dangerous and liable to cause serious laceration of the tissues. For this reason, an instrument that does not possess closely-fitting teeth should be discarded. As to whether a volsella should possess multiple or single teeth, this point may be left to the personal predilections of the surgeon. The single-toothed volsella is preferred by many, and it certainly does not produce as much damage to the tissues as is sometimes done by the type with multiple teeth. A useful and satisfactory form of volsella with single teeth is shown in Fig. 95 (b).

The tenaculum has much the same scope in examination as the volsella, but has not the same value. The instrument consists of a sharp-pointed hook mounted upon a long handle. It is used in conjunction with specula for exposing and steadying the cervix and adjacent parts. It is perhaps easier to use than the volsella, but its grip is not so secure. The shanks of both volsellae and tenacula are sometimes slightly bent in order to prevent the handles obstructing the line of direct vision with the cervix. This is really an unnecessary refinement, and for practical purposes the straight-handled instruments are to be preferred and last longer. Both sharp-pointed volsellae and tenacula occasionally produce bleeding from the punctured surface of the cervix. This can be readily checked by pressure with a wool or gauze swab mounted upon forceps.

The Uterine Sound.—This is an instrument upon which much has been written and many diverse opinions expressed. In the hands of the expert it may be of great value, but the dangers which attend its indiscriminate use are so grave that its employment in the hands of the inexperienced or careless is fraught with considerable risk to the patient. The information gained by means of the sound, as a rule, is concerned with the details of diagnosis such as are required from the specialist. For this reason, and because of the dangers which attend its careless use, the practitioner does not require the instrument as a part of his armamentarium. The place of the uterine sound in gynaecology was established by Sir James Simpson, and it undoubtedly did much towards placing diagnosis upon a sound scientific basis. In its earlier days the instrument was freely used without due observance of the tenets of antiseptis and asepsis, inasmuch as the principles underlying the same were as then unknown. This fact accounted for many of the evils which originally attended its use. It is important, however, to remember that the same risks hold good to-day if the ordinary canons of antiseptis are disregarded.

In its original form the instrument, which in many centres is still in use, measures 12 inches in length. It is a metal probe, curved forward in its distal 3 inches, and marked by a circular ridge $2\frac{1}{2}$ inches from the rounded, slightly



FIG. 96.—Exposing the cervix uteri by means of Sims's speculum and a volsella previous to the introduction of the uterine sound.

bulbous tip. The instrument is graduated by means of notches 1 inch apart, commencing below the circular ridge, which registers the normal length of the uterine cavity. In the original sound a notch was present at a distance of $1\frac{1}{2}$ inches from the tip. This has been discarded, since it was of little practical use and was a source



FIG. 97.—Playfair's probe, dressed with cotton wool for the application of medicaments to the cervical canal and to the endometrium.

of weakness to the instrument. The sound is made of flexible metal in order to allow of its adaptability to any curve of the uterine cavity. The handle is flattened and should be roughened on the side corresponding to the point.

Before discussing the uses to which the instrument may be put, and the contra-

indications to its employment, it is well to note the *technique* to be observed during its introduction. In the first place, every precaution must be taken to prevent the introduction of micro-organisms into the uterine cavity. The instrument should be boiled before use. The hands of the examiner and his assistant are thoroughly cleansed and covered with sterilized gloves. The cervix uteri is then exposed by a tubular or Sims's speculum, and sterilized as far as possible by the application of antiseptic lotions. Solutions of iodine are useful for this purpose, the one in constant use by the writer consisting of a $2\frac{1}{2}$ per cent solution of iodine in ethylene bi-chloride. In order to sterilize the cervix completely, and also to facilitate the introduction of the sound, it is usually necessary to seize the anterior lip of the cervix in a volsella (Fig. 96). Menge has shown that the uterine cavity is normally sterile. On the other hand, the cervical canal frequently contains various germs. For this reason, it is well before passage of the sound to sterilize the cervical canal as far as possible by iodine, applied on a dressed Playfair's probe (Fig. 97). As to the type of speculum to be used for exposure of the cervix, some surgeons prefer the tubular variety since it is possible to introduce the sound without the risk of contamination from the vaginal walls. Owing to the rigidity of the speculum, the restriction of space, and the degree of flexion of the extremity of the sound, difficulty may be experienced in the introduction of the latter, and for this reason one of the bladed specula is preferable. The patient is placed in the semi-prone position; Sims's speculum or one of its modifications is then introduced, and the anterior lip of the cervix seized by a volsella. Traction is exerted in a direction towards the vaginal outlet in order to render the cervix as accessible as possible, besides straightening the uterine canal. The sound is then taken between the fingers of the right hand with the concavity pointing forwards, if it is presumed that the uterus is in its normal position. The point of the instrument is introduced into the cervical canal as shown in Fig. 98, and passed slowly and steadily upwards and forwards until the tip is felt to impinge against the fundus uteri. No force must be used, and the sound should be passed almost entirely by its own weight. If the uterus is retroverted, the instrument is introduced with the concavity pointing backwards towards the patient's sacrum (Fig. 99). In each case introduction is facilitated by moving the handle in a direction opposite to the point, as the instrument is passed onwards. If in its upward progress, obstruction is encountered at the level of the os internum, or by a fold of cervical mucous membrane, the instrument should be withdrawn and reintroduced. No undue force should be used. With the aid of a Sims's speculum and a volsella, it is always possible to introduce the sound without bringing the instrument into contact with the vaginal walls, and owing



FIG. 98.—Introduction of the uterine sound, the uterus being in its normal position. The cervix is exposed by means of Sims's speculum; its anterior lip is seized by a volsella, and the tip of the sound is introduced into the cervical canal. The concavity of the instrument looks forward.



FIG. 99.—Introduction of the uterine sound when the uterus is retroverted. The concavity of the instrument points backwards towards the patient's sacrum.

to the better access afforded by this means, the method is to be preferred to that involving the use of Ferguson's speculum. In marked displacements of the uterus some difficulty in introducing the sound may be apprehended. Thus, when the organ is acutely anteflexed, the end of the sound must be sharply curved and the cervix brought down as low as possible into the vagina. When retroversion is present there is rarely any difficulty experienced, since the uterine cavity and vaginal canal form one straight line. In the case of retroflexions, the sound should be introduced

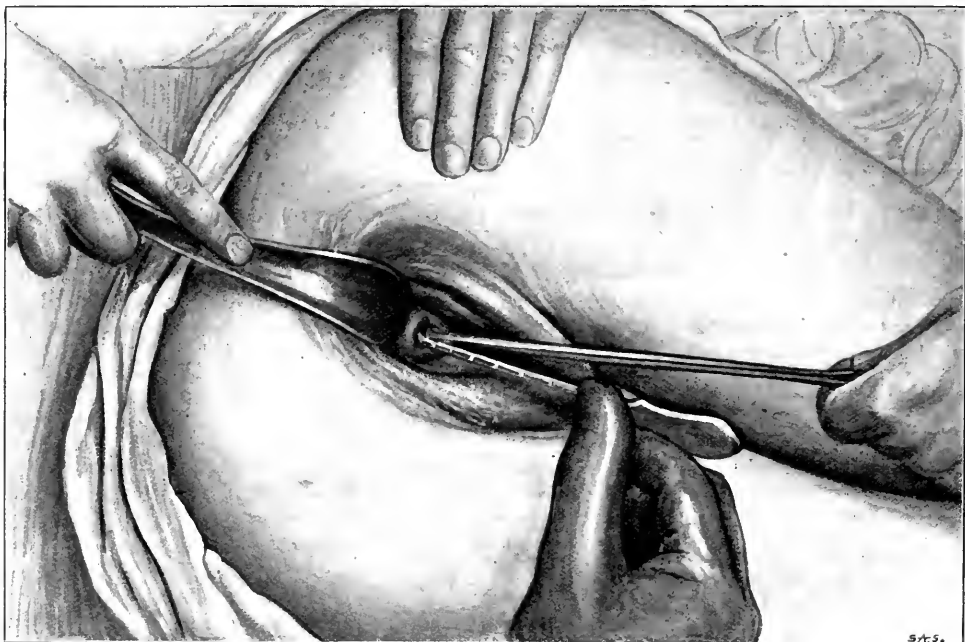


FIG. 100.—Position of uterine sound when performing the *tour de maître*. The handle of the instrument is carried forwards in a semicircle from the position it occupies in the previous figure until it reaches the one indicated here.

in the usual manner until the os internum is reached. The instrument is then rotated until the concavity is directed posteriorly, when the point readily passes into the uterine cavity by carrying the handle forwards. If it is desired to replace the uterus the handle is again rotated forwards, using the point of flexion as the fulcrum. It is then carried directly backwards, thus raising the distal extremity and with it the corpus uteri. This simple manœuvre, known as the *tour de maître*, is shown in Figs. 99 and 100.

In considering the *indications* for the use of the uterine sound, it may be stated that the greater the examiner's acumen in bi-manual palpation, the less frequently is this instrument necessary. It is by no means always requisite, and it should

be employed only when the information cannot be obtained in any other way. To the experienced observer, the information that may be derived from the proper use of the sound may be divided into the following headings :

- (1) Alterations in the length, width, and direction of the uterine cavity.
- (2) The degree of mobility of the organ.
- (3) Irregularities of the surface of the endometrium.
- (4) The demonstration of a double uterus.
- (5) The recognition of occlusion or stenosis in the cervix and corpus uteri.

The most common use to which the instrument is put is undoubtedly to measure the length of the uterine cavity. Thus, it is employed as a preliminary to dilatation of the cervical canal previous to the operation of curetting. It is possible, of course, to obtain a very exact estimate of the size of the uterus by the bi-manual method of palpation. At the same time, it gives no indication of the relative length of the uterine cavity and the thickness of the uterine walls. This can only be done by comparing the findings of the one with the direct measurement obtained by the other. In conditions of atrophy, diffuse hypertrophy, and fibromyomata of the uterus, the sound may often be employed with advantage. With regard to the last mentioned, however, a note of warning should be sounded in the case of large tumours. The uterine canal in these cases is not infrequently considerably distorted, and the risk of perforation and infection of the tumour by the instrument is very real. Also in advanced cancer of the body of the uterus perforation may be readily produced, with grave risks of peritoneal infection. It should therefore not be employed as a routine method of diagnosis in such instances. Displacements of the uterus are as a rule quite easily recognized by palpation, but occasionally the sound is of use in differentiating a retroflexed uterus from a small interstitial fibromyoma of the posterior uterine wall, or acute ante flexion from a similar growth in the anterior wall of the uterus. In the cases of very obese patients, bi-manual examination is impossible, and under these circumstances the instrument may be used to ascertain the position and size of the uterus. Whenever the direction of the uterine canal is unknown, however, the greatest care must be observed by the examiner to avoid producing trauma or perforation of the viscus.

As regards the value of the uterine sound in recognizing irregularities of the uterine endometrium, and the diagnosis of intra-uterine neoplasms, much depends upon the skill and experience of the examiner. By some authorities it is asserted that such precision of diagnosis is not possible. This is indeed true in the case of some intra-uterine tumours, and even large swellings almost filling the whole uterine cavity may be overlooked. It is quite impossible to diagnose such soft masses of

tissue as adenomatous polypi, but fibroid polypi can occasionally be recognized owing to their firm consistence. On the other hand, irregularities on the surface of the endometrium are quite evident with the aid of the sound. This is particularly the case with carcinoma and retained products of conception, which can be appreciated by the sound almost as readily as by the finger. The healthy endometrium feels quite smooth, although at the centre of the fundus a normal prominence can frequently be detected, situated midway between the cornua. Recognition of irregularities in the uterine wall requires considerable practice and a definite routine should be employed. It is well to commence at the fundus and then to explore respectively the anterior and posterior walls and cornua. In using the sound for this purpose, the instrument is passed gently over the surface moving the point in various directions over a small compass. Although the pressure should be firm no undue force is used.

As a rule, the passage of the uterine sound is attended by a negligible degree of discomfort. Occasionally in the case of hypersensitive and nervous women, some pain is produced as the point of the instrument passes through the os internum. Such patients are not infrequently subjects of dysmenorrhoea. In the presence of recent pelvic inflammation, or the results of the same as represented by adhesions, the passage of a sound is almost invariably accompanied by considerable pain. Under such circumstances, however, the instrument is most certainly contra-indicated.

The *contra-indications* to the use of the sound are important. They are as follows :

1. *Pregnancy*.—Before the instrument is passed a very careful history should be taken of the menstrual function, particularly as to the date of the last period. If there has been amenorrhoea for even a short period, the use of the sound is contra-indicated. It is true that, during the earlier months of pregnancy, the instrument may sometimes be passed without the production of abortion. This is because the trauma happens to be insufficient to cause the death of the ovum. When the gestation has progressed sufficiently far for the ovum completely to fill the uterine cavity, the introduction of a sound into the uterus almost invariably results in its death. Under certain circumstances the accident of introducing a sound into the pregnant uterus may occur, as, for example, when a patient suspecting herself to be pregnant, wilfully misguides the physician with regard to the date of her last menstruation. Occasionally a patient may become pregnant during the course of treatment, and a sound be introduced without further reference being made to the catamenial function. It may happen also that the pregnant uterus menstruates regularly during the early months of gestation, and this fact will throw the practitioner

off his guard if he does not take the precaution of carefully weighing the physical signs obtained by bi-manual examination before he has recourse to the sound.

2. *The Presence of a purulent or infective Discharge about the Vulva or Vagina.*—

The use of the uterine sound is of course contra-indicated in the presence of all infective discharges in the region of the genital passages, since germs may easily be conveyed to the uterine cavity by this means. Difficulty is liable to arise in the case of sub-acute and chronic infections, particularly of a gonococcal nature. These lesions are frequently difficult to recognize, inasmuch as the germs lie deeply buried in the depths of the cervix. When implanted upon fresh tissues, however, they are liable to take on renewed activity, and produce rapidly spreading acute infection of the upper genital tract, even extending as far as the peritoneum. This accident can only be prevented by carefully abstaining from passing the sound whenever there is the least suspicion of any discharge of a doubtful nature about the cervical canal, Bartholin's ducts, or the crypts of the urethral mucosa.

3. *Recent Inflammation of the Uterine Adnexa.*—The use of the sound under such conditions is more than likely to lead to exacerbation of inflammatory mischief in relation with the Fallopian tubes, ovaries, or parametrium. The reason for this is that owing to traction upon the cervix and the displacement of the uterus during the passage of the instrument, adhesions are broken down and organisms which were walled off are reinoculated on to new ground. In chronic inflammation associated with numerous adhesions, the passage of the uterine sound is not to be recommended, since the manipulations may lead to laceration of adhesions apart from the risk of fresh inoculation, and renewed activity on the part of micro-organism.

The *dangers* which attend the careless use of this instrument have largely been covered by the foregoing remarks. The greatest risk is undoubtedly perforation of the uterus. This accident is liable to happen not only to the inexperienced practitioner but also when the greatest care is exercised in the passage of the sound. It is not uncommon in fact for slight injuries to the uterine wall to be produced, but if the organ is healthy its musculature normally resists the passage of the instrument and prevents perforation. When atrophy is present, however, or the organ softened by fatty or septic changes, or even by malignant growth, perforation may occur without the employment of any force whatsoever. No resistance is encountered, and the examiner suddenly finds that the instrument has passed far beyond its normal limits. If due aseptic precautions have been taken, and the uterus itself is unaffected, little risk is likely to follow this accident. No further manipulations of any kind should be attempted, and the patient kept in bed for a few days. If,

however, it is known that the uterus contains infective material, such as a degenerating or malignant neoplasm, or decomposing products of conception, one of two courses may be adopted. Either expectant treatment may be instituted and the patient kept at rest in Fowler's sitting position, or drainage of the pelvis performed at once through the posterior vaginal fornix. In highly infective conditions the latter appears to be the wisest precaution. If the aperture in the uterine wall is only small, such as is produced by perforation by the sound, this measure is usually sufficient without having recourse to abdominal section. The second risk attending the use of the instrument is the introduction of micro-organisms from without by using an infected instrument. Inflammation may thus be set up which extends through the Fallopian tubes to the ovaries and peritoneum. Reference has already been made to this matter and therefore no further mention is required. Occasionally severe haemorrhage may follow the use of the uterine sound. The occurrence of bleeding during the passage of the instrument is always of interest, and in the case of elderly patients is an important sign in the diagnosis of carcinoma. If the uterus contains placental tissue, haemorrhage may be severe and require packing of the organ to control it, if facilities are not at hand to explore the cavity and remove the bleeding tissue. It follows therefore from the preceding remarks that although the sound in experienced hands may be and is an instrument of great utility, its general use is to be deprecated, since its employment by those unskilled in its use is liable to be followed by accidents of a very grave nature.

Dilatation and Palpation of the Uterine Cavity.—For the more exact diagnosis of disease affecting the uterine cavity it is necessary to explore digitally the interior of the organ. Except in the presence of a recent gestation it is always necessary to dilate the cervical canal to permit the introduction of the exploring finger. Access to the uterine cavity may be obtained either by division of the cervix or by dilatation of its canal with metal dilators or tents. These methods are of the nature of minor operations and are discussed in the section dealing with this subject (Vol. II. p. 675).

THE MICROSCOPE IN GYNAECOLOGY

Amongst auxiliary methods of examination, microscopic diagnosis is of the very greatest value to the gynaecologist in investigating the nature of obscure lesions affecting the genital tract. It not infrequently happens that the naked-eye appearances of tissues are insufficient to warrant an exact diagnosis. A common example of this occurs in the examination of material for malignant disease. In the case of the cervix, for instance, it is sometimes impossible to ascertain the existence of malignancy by

the ordinary methods of palpation and inspection. Under such circumstances, exploratory excision of a portion of the tissue must be made, and the section submitted to careful microscopical examination. The same remarks apply to the investigation of fragments of the uterine endometrium obtained by curettage. In diseases affecting the endometrium, the microscope is of the very greatest value in providing means for positive diagnosis, since the uterine cavity cannot be directly inspected, and palpation by sound or finger frequently fails to show any



FIG. 101.—Sterilization of the vaginal cervix by means of solutions applied upon a swab mounted on speculum forceps. The use of a Ferguson's speculum prevents caustics or irritants from coming in contact with the vaginal walls.

gross physical change. Without the aid of microscopy, in fact, many serious errors may be committed, particularly in the diagnosis of cancerous and pre-cancerous conditions. Thus, evidence of malignancy may be present in tissues when it is least expected; and on the other hand, in a patient who presents symptoms of uterine cancer the microscope may reveal a perfectly benign condition. Microscopic examination of the endometrium is a matter of such great importance that it should form a routine part of the examination whenever the curette is used. In fact, this latter instrument is of much more value for diagnostic than for therapeutic

purposes. The urgent necessity for early diagnosis of uterine carcinoma has placed curettage of the endometrium and excision of a portion of the cervix in the forefront of methods of examination. It is necessary therefore to consider in some detail the method adopted in obtaining and preparing tissue for microscopic examination.

Curettage of the uterine cavity is discussed under the heading of minor operations (Vol. III. p. 680). Excision of a portion of tissue, however, is a trivial matter



FIG. 102.—Complete exposure of the vaginal cervix by traction upon the anterior lip with a volsella. Unless a certain degree of prolapse is present it is usually not possible to obtain such complete exposure as shown.

which may well be considered in the present section. The method is of course only applicable when the lesion is easily accessible. It may be employed in the case of all conditions of doubtful nature affecting the vulva, vagina, or vaginal cervix. It is perhaps most frequently used in connection with lesions of the cervix in the diagnosis of early carcinoma. The technique observed in obtaining a portion of the cervix for microscopical purposes is as follows: The patient is placed in the lithotomy or semi-prone position. If general anaesthesia is not employed, and as a rule

it is quite unnecessary, Sims's position is to be preferred. The vulva, vagina, and cervix are carefully sterilized by the administration of an antiseptic douche and the application of a solution of iodine (Fig. 101). The cervix is then exposed by means of a speculum, and its anterior lip seized and steadied by a volsellum (Fig. 102). The area for excision having been selected, a wedge-shaped section of tissue is removed with the aid of a long-handled knife or sharp scissors. This area should include the junction between healthy and diseased tissue for purposes of comparison. As a rule, there is very little haemorrhage, and this can always be controlled by the insertion of one or more catgut sutures. A strip of antiseptic gauze may be placed in the vagina and closely applied to the vaginal cervix. It should be removed within 24 hours. It is advisable for the patient to remain in bed for 24 hours afterwards, although this is not absolutely necessary. The tissue which has been removed should be placed at once in a hardening solution.

Preparation of Tissues for Microscopic Examination.—For a complete exposition of the principles and technique for the microscopical preparation of tissues, works on practical histology should be consulted. Owing to the great value of the microscope in diagnosis, however, the examiner should be familiar with those methods of preparing tissues which have been found to be most useful in the study of gynaecological pathology.

Two methods are available: (a) the examination of fresh material, and (b) the examination of hardened material.

(a) **Examination of Fresh Tissues.**—In general this method is but little used, although occasionally it is of value in expressing a positive diagnosis without the expenditure of the time required for the more detailed processes. Chorionic villi are easily recognized, as also are uterine glands and ciliated epithelium of the endometrium. The presence of sarcomatous cells can also be detected. The technique employed is as follows: In the case of curettings and small pieces of tissue, minute fragments are picked out with forceps and placed directly upon a microscopic slide in a solution of water and glycerine, or iodine and potassium iodide. The tissue is carefully teased out and examined at once under a cover-glass. When the specimen is a tumour, it is more desirable to examine the juice obtained by scraping the surface with a knife than to tease out the solid structure. Thus in the case of sarcomata, the juice always contains cells upon which a diagnosis may be formed. Fresh unhardened sections as a rule are unsatisfactory when stained. If, however, an expression of opinion is required at once, Löffler's methylene-blue may be used for staining purposes.

(b) **Examination of Hardened Material.**—As a general rule it is desirable to fix

and harden tissues before cutting, since the resultant preparations are not only easier to manipulate but provide much greater detail. Several fixing agents are available. Perhaps the most generally useful is formalin in a 5 per cent aqueous solution. Alcohol in increasing strength up to 96 per cent is also a valuable hardening and fixing agent, particularly for curettings and small portions of tissue. For neoplasms and larger sections of tissue, Müller's fluid, Zenker's solution, and Flemming's solution can be recommended. Whatever material is employed, the sections should not be unduly large, and in the case of curettings care must be taken to obtain the tissue as free from blood-clot as possible. This is not always an easy matter owing to the rapid coagulation of blood when brought into contact with the endometrium. The clot may be rendered looser and more easily detachable by receiving the curettings from the uterus into a saline solution. This exerts a partially solvent action upon fibrin. In the collection of curettings for microscopical examination, it is very important to select many fragments of tissue inasmuch as the appearances of the endometrium at all parts are not identical. Tissue from whatever source should be placed at once in the hardening fluid, and on no account should it be allowed to dry in contact with the air or become sodden in watery solutions. Unless these precautions are observed, much detail is lost and false impressions are formed. It is sometimes recommended in the case of curettings to receive the tissue directly into alcohol, which not only fixes the cells but coagulates the blood in a finely granular condition. In the writer's experience, however, this method cannot be recommended, since it is difficult to obtain the tissue free from adherent clot in spite of repeated washings. When a large portion of tissue, such as a tumour, requires microscopical investigation, portions should be excised from several different parts. It is quite insufficient to select a single area.

Freezing Sections.—In ordinary surgical work, a rapid and efficient method of preparing tissues for microscopic examination is a great desideratum. If it is desired to examine a specimen with the least expenditure of time, the method of preparing sections by the freezing-microtome possesses many advantages. In the case of small fragments of tissue, the material is ready for freezing after immersion for from half an hour to two hours in the hardening solution. If alcohol has been used as the fixative, the latter should be removed with formalin, and the tissue then washed in water. If, on the other hand, formalin has been employed, washing in water is sufficient. For freezing, ether or carbon-dioxide snow may be used. Within recent years, Cullen's method of preparing sections by rapid fixation with carbon-dioxide snow has come to the fore, and a very excellent apparatus for obtaining sections by this method is now on the market. After cutting, the

sections are dehydrated by alcohol, stained, cleared by xylol, and mounted in canada balsam. By this process it is possible to obtain a report upon any tissue in from one to two hours. If, on the other hand, fixation by carbon-dioxide alone is employed, a reliable opinion can be expressed in from 15 to 30 minutes after removal of the tissue. When possible, however, it is better to fix the material in alcohol or formalin, since by this means thinner sections are obtainable and blurring of the resultant picture is avoided.

Embedding of Tissues.—As a general rule better sections are obtained when the tissues are embedded in some material which holds the structure together during the processes of cutting, staining, and mounting. The preparation of sections in this way is undoubtedly the method of choice when extreme urgency is not called for. They are more easily prepared, particularly if it is necessary to cut a long series, and furthermore, the results are undoubtedly better. Two methods are in common use, viz. the celloidin method and the paraffin method.

The Celloidin Method.—A solution of celloidin in ether, in varying strengths, is prepared. The tissue to be examined should be cut into small fragments, and after complete dehydration in absolute alcohol, is placed in a mixture of ether and alcohol for a period varying from 1 to 24 hours according to the size of the section. It is next immersed in a weak solution of celloidin, and transferred subsequently to stronger solutions of the same. Here again the length of time during which the tissue remains in the celloidin solution depends upon the thickness of the individual pieces. It may vary in fact from 2 to 24 hours. Embedding is performed by pouring the celloidin solution containing the tissue into a suitable cell or cast and allowing the ether to evaporate until the celloidin reaches an elastic consistence. The pieces are then placed in a 66 per cent solution of alcohol. This hardens the material to a firm block. The latter is usually attached to a small piece of wood by dipping one end of the celloidin into alcohol in order to make it adhere. In preparing the block, precaution should be taken to arrange the tissue in the desired plane for section with the microtome. Unless this is done, a false impression may be gained when the tissue is viewed under the microscope. Sections may be cut and stained at once, or preserved for further reference in a solution of alcohol (60 per cent). To mount permanently, the sections, which are best handled with a brush, are washed in water, stained, dehydrated in absolute alcohol, and mounted in canada balsam after being cleared in xylol. Clearing should be complete, and the presence of white opaque areas shows that dehydration is deficient. At the same time the tissue must be removed from the alcohol when the celloidin commences to dissolve. Methods somewhat allied to celloidin are embedding by means of albumen, and gum arabic

and glycerine. These also produce very excellent sections, but are not so reliable as the process just described.

The Paraffin Method.—Embedding by paraffin is perhaps more largely employed in this country than the preceding. It has the advantage that the blocks may be stored dry without the inconvenience of bottles containing fluid. After hardening in one of the fixation-agents previously mentioned, the pieces of tissue are dehydrated, first in methylated spirit and then in absolute alcohol. The alcohol is eliminated by carrying them through one or more baths containing xylol or chloroform. It is necessary to remove chloroform or xylol as far as possible, and therefore before embedding, the tissue should be placed in a bath containing paraffin, heated to a temperature not exceeding 50° C. They may remain in this bath for 12 hours, and are then ready for embedding in paraffin. During this process care should again be taken to arrange each specimen in the position required for cutting. This is particularly important in the case of some specimens, *e.g.* it may be necessary to show the thickness of the endometrium and its attachment to the metrium. A tangential section of the endometrium under such circumstances would fail completely in demonstrating what was required. After embedding, the paraffin blocks are trimmed to a convenient size and stored in boxes or cabinets for subsequent reference.

Preparation of Microscopic Sections.—It is not necessary to describe in detail the various processes for mounting microscopical preparations of tissue. These are adequately dealt with in text-books on practical histology. Attention need only be drawn here to a few of the more salient points in connection with the mounting of gynaecological preparations. The importance of the plane of section has already been emphasized. It is in fact essential in the case of preparations involving mucous membrane to have the plane of section as nearly as possible perpendicular to the free surface. In connection with the mounting of fragments, such as curettings, this is not always possible. At the same time, with the expenditure of a little care during the process of embedding, the resulting section can generally be relied upon to provide the required information. With tumours, sections should be prepared in different planes, two of these being superimposed vertically. It is not *always* necessary for sections to be extremely thin; in fact, in the case of the endometrium rather thick sections are sometimes to be preferred. As a rule, it is unnecessary for a section to be thinner than 10 μ , and for ordinary purposes 15 μ to 20 μ is ample. The finer work may be reserved for neoplasms, chorionic villi, etc. If canada balsam is employed as the mounting agent, care should be taken not to use an excess; otherwise much depth of colour is lost if the sections are stored for any length of time.

Stains.—The methods of staining various tissues are exceedingly numerous. For ordinary purposes haematin, haematoxylin, or alum-carmines may be recommended. These materials are essentially nuclear stains, and it is necessary to employ a counter-stain having an affinity for the connective tissues. Of these, van Gieson's, eosin, and picric acid are in general use. The sections are placed in haematoxylin for a period varying from 8 to 15 minutes. They are then washed in distilled water and placed in ordinary tap water, where they remain for half an hour. If eosin is used as a counter-stain, they are passed through an alcoholic solution of the same for 1 to 2 minutes, and then rapidly dehydrated in absolute alcohol. Care must be taken during this process that the eosin is not removed. In the completed section, mounted in xylol and canada balsam, the connective tissues appear red and the nuclei blue. If van Gieson's method is used, the tissue must be slightly overstained with haematin or haematoxylin, since much of the stain is lost in the subsequent processes of washing, clearing, and mounting. For special purposes, other methods may be employed. Amongst these may be mentioned the borax-carmines process for staining embryonal tissues, the Unna-Pappenheim method for the exhibition of plasma cells, and the Benda or Weigert when minute detail of structure is required. For determining the spread of cancer into surrounding tissues, the muci-carmines staining process may be recommended. Similarly, to show the presence of treponemata, either Levaditi's or Giemsa's method should be used. For these special processes, text-books on microscopical technique should be consulted. (See also Vol. I. p. 119.—EDITORS.)

Cause of Errors in Microscopic Diagnosis.—Although the microscope is of the greatest value in forming an exact diagnosis, guard must be kept against certain possible errors. Some of these mistakes may be prevented by the exercise of sufficient care, whilst others are due to want of knowledge in methods of distinguishing between normal and pathological tissue-changes. Thus, all pathologists recognize the difficulty of distinguishing a sarcoma-cell from one of purely physiological function as in the case of the decidua or a fibromyoma. A small-celled sarcoma at times closely resembles the infiltration of tissues by inflammatory cells. Also it is extremely difficult to distinguish the columnar cells of a simple uterine adenoma from those of early carcinoma. During the pre-menstrual stage of development of the endometrium, this difficulty is much increased, and before an expression of opinion can be given upon the appearance of uterine curettings, the relation of the tissue to the menstrual function must be known.

In the diagnosis of malignancy, many sources of error occur. Thus the tissue supplied for examination may be too small in amount. In the case of curettings all the fragments obtainable should be carefully collected, washed free

from blood-clot and included in the block for section. It is not sufficient to select what appears to be the largest piece and rely upon the appearance of this alone. It may happen, for example, that malignancy is limited to one area, and in the earliest stages of carcinoma when diagnosis is so requisite, this must be so. Also in cases of obscure uterine bleeding, it not infrequently happens that curettings taken from different parts of the uterine cavity present very different appearances, and this in all probability has an important bearing upon the clinical features of the case. With respect to tumours, whenever there is doubt as to malignancy, several sections should be taken from different portions of the growth. One or more of these should include the line of junction between the healthy and diseased tissues, since at this point the cells of the neoplasm have undergone no degeneration, and a clearer picture is obtainable. Necrotic and degenerated tissues very rarely give much information when stained. This is particularly the case with malignant and tubercular lesions. Even when every care has been taken in the preparation of the section and in its subsequent examination, mistakes will occur, particularly in the diagnosis of malignancy. Illustrations of this fact are seen in the errors that arise in the diagnosis between sarcomata and fibromyomata, hydatid mole and chorionepithelioma, carcinoma and adenoma malignum. Whenever there is a question of doubt as to the nature of the tissue, one or more sections should be prepared, and stained by different methods. For this reason the original material should never be thrown away until an opinion based upon microscopic findings has been expressed.

BACTERIOLOGICAL EXAMINATION

Bacteriological methods are frequently employed with advantage in the investigation of disease affecting the female pelvic organs. They are especially useful in the examination of discharges, and should form part of the routine investigation of all inflammatory lesions in connection with the genital tract. Two methods are available: (a) microscopic, (b) cultural. In the past, the first of these methods has often been made to suffice. At the best it is incomplete, and whenever possible should be supplemented by the culture of the organism involved. The micro-organisms affecting the genital passages fall into two categories, viz. (i.) aërobic, and (ii.) anaërobic.¹ Quite recently Curtis has shown the importance of anaërobic organisms in the production of vaginal discharges. Owing to the large number and diversity of the germs present in the vagina, isolation and detection of any specific organism is no easy task, and the services of a

¹ See also Article on Types of Micro-Organisms met with in the Female Genito-Urinary Tract (p. 97).—EDITORS.

competent bacteriologist should be available for the detailed examination required. Organisms of pathological importance for which examination is most frequently required are : (a) gonococci, (b) staphylococci, (c) pneumococci, (d) streptococci, (e) bacilli of the coliform group, (f) tubercle.

More rarely it may be necessary to identify the organisms of diphtheria, syphilis, and actinomycosis. Recent work appears to prove that other germs of anaërobic properties have a pathological significance, and it is probable that no bacteriological examination can be considered complete unless it involves the anaërobic as well as the aërobic differentiation of the organisms present. The complicated methods employed in staining and differentiation of the same may well be left to the bacteriologist, but the gynæcologist should be acquainted with the methods of obtaining material for investigation, including : (1) the collection of pus by means of the platinum loop ; (2) the taking of a swab.

A platinum wire loop is most commonly used to obtain material for a film in the microscopic examination of pus and other fluids. The method is employed for example in the case of vaginal discharges and fluid contained within a pyosalpinx, ovarian cyst or abscess, or the peritoneum. In the case of vaginal discharges, a special technique is adopted. The patient is placed in the dorsal position, and the cervix exposed by means of a speculum. A drop of secretion is then transferred with a platinum loop directly from the cervical canal to a glass slide, or to a suitable medium for culture, if cultural methods are employed. A second film is prepared from pus expressed from the ducts of the urethra and Skene's tubules by direct pressure upon the anterior vaginal wall with the index finger. If any purulent secretion is seen exuding from the ducts of Bartholin's glands, it should be collected in a similar manner. These precautions are necessary, since specific and pathological organisms are most likely to be met with in these situations, and moreover are less contaminated by the non-pathogenic germs which swarm in the vagina. With discharges of a gonorrhoeal nature, it is sometimes exceedingly difficult to recognize the specific organism after the acute stage is passed. If the germs are few, it is best to conduct the examination immediately before or after a menstrual period, inasmuch as gonococci at this period are discharged from the deeper portions of the gland-ducts and appear in larger numbers in the secretions. In the preparation of films for microscopic examination, care should be taken to obtain a uniformly even surface. This is effected by selecting a small drop of the fluid to be examined, and diffusing it over the surface of the slide by the glass edge of another held obliquely to the surface. If the fluid is teeming with micro-organisms it is an advantage to dilute with saline or water before the films are prepared.

Method for taking a Swab.—In some situations it is impossible to obtain material for bacteriological purposes by means of a platinum loop. Such is the case with the uterine cavity. Several methods have been devised for obtaining material from the uterus for this purpose. None is entirely satisfactory. In by far the great majority of cases the investigation has to be conducted from the vagina, and the fallacy necessarily arises of contaminating cultures of the uterine cavity with germs present in the vagina or cervical canal. The usual method is to employ a uterine swab, the technique being as follows: The patient is placed in the semi-prone position. Sims's speculum or one of its modifications is introduced, and after thorough sterilization of the vagina and cervix by the application of an antiseptic solution, the anterior lip of the cervix is seized by a volsella.

With regard to sterilization of the cervix, it is insufficient to sterilize only the surface of the portio vaginalis. Organisms normally exist in the cervical canal, and as many of these as possible must be removed by the application of some antiseptic. Iodine is frequently employed for this purpose. If the cervical canal is sufficiently dilated, a glass tube may with advantage be introduced for a distance of one inch. A swab consisting of sterile wool mounted upon a handle is then passed through the glass tube directly into the uterine cavity. It is carried over the whole of the endometrium and withdrawn. Cultures and films are made from the swab immediately, or it may be enclosed in a sterile glass tube and forwarded to a skilled bacteriologist. In many instances the use of a glass tube in the cervical canal is omitted, but inasmuch as the complete sterilization of the cervix is so difficult it appears to be a wise precaution. When the uterus is enlarged and contains a moderate amount of infective material as in the case of puerperal sepsis, the secretion may be collected for bacteriological purposes by means of a Sival's or Döderlein's tube. These tubes are made of glass of narrow calibre, and are bent at an obtuse angle, $1\frac{1}{2}$ inches to 2 inches from the point, as in the case of the uterine sound. They are passed directly through the cervical canal into the uterine cavity, when the secretion flows along the lumen by capillary attraction. After withdrawal of the tube, the ends are closed with sealing-wax, and it is then forwarded to a bacteriologist.

The demonstration of micro-organisms *within the tissues* is a method of examination which is only of use in a few cases. The tissue for examination is usually obtained by excision or curettage, and after fixing is stained by methods appropriate to the suspected germ. Obscure lesions of a syphilitic nature can be diagnosed by the demonstration of the *treponema pallidum* in the tissues. Similarly, by suitable methods of staining, gonococci may sometimes be shown within the cells of the endometrium.

EXAMINATION OF DISCHARGES FROM THE GENITAL ORGANS

The examination of discharges from the genital organs is a subject deserving of an important position in the investigation of diseases of this tract. To be complete it should include a survey of the physical, bacteriological, and chemical characters of the secretions involved. Discharges occur commonly in relation with the vulva, vagina, and uterus, and more rarely the Fallopian tubes. They fall into two categories: (a) physiological, and (b) pathological. The normal discharges consist of secretions from the glands in connection with the uterus and vulva mingled with a transudation from the vaginal walls. The secretion from the glands of the *corpus uteri* is thin and watery in consistence with an alkaline reaction; that from the cervical glands, on the other hand, is glairy and tenacious, containing a large quantity of mucin. A discharge from the vagina, both in single and married women, is so common that it may almost be regarded as physiological. It is usually white or creamy in colour and consistency, and is commonly known as *leucorrhoea* or whites. It consists of secretions from the uterine glands together with fluid transuded directly through the vaginal walls, and it contains epithelial cells derived from the vagina and cervix, a few pus cells, and numerous micro-organisms both aërobic and anaërobic. In reaction it is acid, due to the presence of lactic and β -oxy-butyric acids. Lactic acid was originally thought to be due to the action of certain micro-organisms, in particular the long rod-shaped bacilli described by Döderlein. Maxwell¹ has shown, however, that the vaginal secretion of infants also presents an acid reaction before it is contaminated by germs from without. Certain acids are therefore probably the result of fermentation. The secretion from the vulva is derived from the sebaceous glands in relation with the labia. Bartholin's gland also provides a watery discharge under stimulation. In addition to the preceding, a periodic monthly discharge normally occurs from the uterus to which the name *menstruation* is applied.

The examination, therefore, should consist of (a) an investigation of discharges occurring from the genital tract apart from menstruation, and (b) an analysis of the catamenial secretion. The investigation of a discharge apart from menstruation must include an enquiry into its physical, microscopical, and bacteriological characters. Under the first heading a note is made upon its consistence, colour, odour, etc., and effect upon adjacent tissues. Thus, it may be watery, as in the case of breaking-down neoplasms; or urinous, as when associated with vesico-vaginal fistulæ. It may be purulent, such as occurs with gonorrhoea and other inflammatory lesions,

¹ Drummond Maxwell, *Proc. Obstet. and Gyn. Sect. Roy. Soc. of Med.*, 1911.

or faecal in connection with recto-vaginal fistulae. The colour of a discharge is also of some importance. If purulent, it is yellow, and stains the patient's clothes. On the other hand, it may be brown or chocolate-coloured if mixed with blood, or greenish when resulting from a necrotic neoplasm or the decomposing products of conception. The odour is frequently characteristic, as in the case of fistulous communications between different viscera; or exceedingly foul, such as occurs with a necrotic fibromyoma, carcinoma, or a foreign body within the vagina. Special note should be made of the irritating character of a discharge upon the vulva and adjacent parts as shown by the presence of furuncles and intertrigo. Microscopical examination consists of the preparation and examination of films appropriately stained. Such films are valuable in showing the presence of various specific organisms, such as gonococci, streptococci, etc.; or distinctive cells, *e.g.* pus, vaginal, uterine, or malignant cells. Bacteriological investigation of discharges has already been discussed under a previous heading.

The Menstrual Discharge.—The investigation of the menstrual discharge and pathological uterine haemorrhage is so important a subject that it requires special consideration. The writer¹ has recently drawn attention to the fact that for descriptive purposes this discharge should be classified under two headings, viz. (1) contents of the uterus, (2) contents of the vagina. The former consist of thrombus containing epithelial cells, leucocytes, and calcium salts, mixed with the secretion from the uterine glands, containing fibrinolysin. The fluid is alkaline in reaction and gives the spectrum of oxyhaemoglobin. The contents of the vagina, on the other hand, consist of the products of thrombolytic and haemolytic digestion, mixed with vaginal cells and the secretions of the corporeal and cervical glands. This fluid possesses a faint but distinct odour and is alkaline in reaction. In colour it is dark red and gives the spectrum of oxyhaemoglobin. Micro-organisms abound in the menstrual fluid contained in the vagina, but are rare in material obtained from the uterine cavity. Menstrual blood does not clot because it contains no fibrin or fibrinolysin, these substances being normally used up in the production of the intra-uterine thrombus. The formation of this thrombus is stimulated by an excess of thrombo-kinase present in the uterine endometrium. In a case of uterine haemorrhage of obscure origin, it is desirable, therefore, that a careful investigation should be made of the chemical and physiological properties of the haemorrhagic discharge. The points in the investigation to which special attention must be directed are: (1) the presence or absence of thrombi in the fluid within the vagina; (2) the formation

¹ Beckwith Whitehouse, *Lancet*, March 28 and April 4, 1914. Hunterian Lecture, "The Physiology and Pathology of Uterine Haemorrhage."

of thrombi within the discharge after the fluid has been allowed to stand; (3) the thrombolytic power of the secretion as estimated by the amount of thrombolysis occurring in a mixture of normal and menstrual blood; (4) the calcium content of the same contrasted with the calcium content of the circulating blood; (5) the microscopical characters of the deposit obtained after centrifugalization of fluid collected directly from the uterine cavity, in order to obtain an index of the degree of tissue destruction.

The technique employed to obtain material from the vagina and uterus is as follows: The patient is placed in Sims's semi-prone position. A duckbill speculum is introduced and the anterior lip of the cervix seized in a volsella. In cases of pathological bleeding, sufficient fluid for examination is readily obtained in the concavity of the speculum, and may be collected directly from the vaginal cul-de-sac or directly from the cervix as it flows from the uterus. It should be transferred directly to a test-tube and reserved for subsequent examination. To collect material from the uterine cavity, the patient is placed in a similar position, and the cervix and cervical canal carefully sterilized with iodine as described in the method for taking a uterine swab. A glass catheter, of the shape indicated in Fig. 103, is then introduced through the cervical canal into the cavity of the corpus.

Where haemorrhage is in progress, this is a procedure of the greatest ease, and as a rule the fluid flows slowly into the tube. Under normal circumstances, within a few seconds, the stream ceases, and examination of the tube shows that the lumen is blocked by blood-clot. The mixture, consisting of thrombus and the secretion of the uterine glands, is placed in a sterilized test-tube and incubated at body heat for 12 to 24 hours. It is examined at intervals and the amount of thrombolysis noted. In the investigation of a case of alleged excessive uterine bleeding, it is important to appreciate the fact that the amount of red uterine discharge cannot be regarded as a criterion of the severity of haemorrhage, or as an index of the quantity of blood lost. It is necessary to remember that the discharge is produced by the

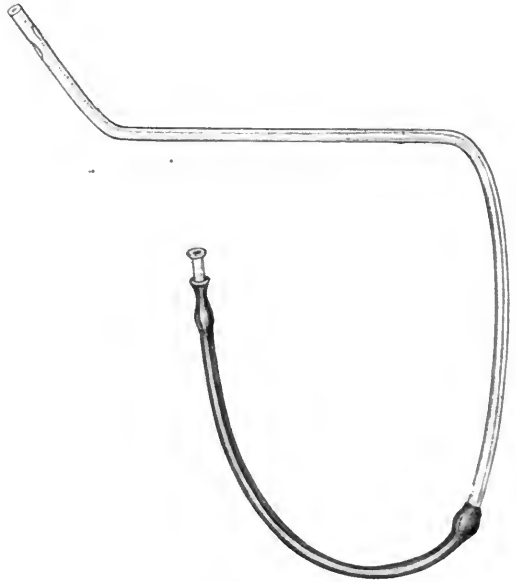


FIG. 103.—Intra-uterine glass catheter for obtaining menstrual discharge from the uterine cavity.

interaction of three substances, viz.: (i.) the secretion of the corporeal glands; (ii.) cells derived from disintegration of the superficial layers of the uterine endometrium; (iii.) blood resulting from the transudation and breach of surface of the endometrium. The total quantity of menstrual fluid can be estimated, but no means are at present available to differentiate between the relative amount of the two chief constituents, viz. secretion of the uterine glands and blood. What is sometimes stated by the patient to be a severe haemorrhage proves upon examination to be largely the secretion of the uterine glands together with a comparatively small admixture of blood.

Two factors remain upon which an approximate opinion of the degree of haemorrhage can be based. The first and most important is the clinical effect produced upon the patient by the supposed bleeding. If, in spite of repeated severe losses, she remains in good health, and her blood shows no marked degree of secondary anaemia, it may be assumed that the discharge consists chiefly of the secretion of the glands rather than excess of blood. The second factor is the occurrence of clots in the discharge. These are of course direct evidence of the amount of blood lost, and in severe haemorrhages are usually present. Their occurrence indicates either (1) that the uterine secretion is deficient in thrombolysin; or (2) that too large a quantity of blood is present for the thrombus to be digested by the available enzyme; or (3) that the escape of blood from the surface of the endometrium is too rapid for the fluid to come in contact with the fibrinolysin present in the uterine secretion. Nature's ideal is to produce an exact balance between the thrombotic and thrombolytic functions of the endometrium, but that this equilibrium is easily upset is shown by the fact that 50 per cent of all women at some time or other in their lives pass clots. There has been in the past a tendency to avoid a detailed investigation of the menstrual and other haemorrhagic discharges, partly no doubt owing to a wish to respect the feelings of the patient. As a rule, however, when the necessity for such examination is explained, no serious objection is raised.

Radiography and Female Pelvic Disease.—Examination by the Röntgen or X-rays has not a very wide application in routine gynaecological diagnosis. The reason for this is mainly twofold. In the first place the organs involved are as a rule readily accessible to more direct methods of investigation, and secondly, the lesions which affect these organs in by far the greatest number of cases do not produce conditions which are impervious to the rays. At the same time, radiography is on occasion a useful accessory method of examination, and a brief reference may be made to a few of its more important applications. It is particularly valuable in the detection of foreign bodies introduced

into the uterus or bladder. It may also be used in the diagnosis of dermoid cysts and teratomata containing teeth or bones. Calcification in fibromyomata and other pelvic tumours gives rise to shadows which may prove important points in diagnosis. At the same time care must be taken in the case of these rounded or oval tumours not to confuse the same with calculi in the bladder. X-rays have also been valuable in diagnosing calculi in the course of the ureter. Here again, however, direct catheterization of the ureters is usually necessary, in addition, in order to prevent errors due to shadows produced by phleboliths or calcified lymphatic glands. Finally, this method may be used to demonstrate the existence within the abdomen of a foetus, particularly a lithopaedion. As a general rule, however, the diagnosis may be made in such cases from a careful comparison of the patient's history with the physical signs, without having recourse to radiography.

THE EXAMINATION OF THE BLOOD

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IN this article only those methods of blood examination are described which yield results of proved clinical significance. Such determinations, for instance, as those concerned with the alkalinity, viscosity, and coagulability of the blood, though possessing a certain scientific interest, have not yet found a settled place in clinical pathology; in some cases because the methods at our disposal do not yield sufficiently exact results, and in others because we are unable to interpret the variations which undoubtedly occur. Investigations which are of proved clinical value, but which possess little or no bearing on the problems usually encountered in gynaecological practice, are omitted, or referred to without descriptive detail. No actual details of technique are given, and for these the reader is referred to the many excellent text-books on clinical pathology and allied subjects.

The principles which underlie the various tests are in most cases fully set forth, and the greatest importance has been attached throughout to a thorough consideration of the clinical interpretation of the results obtained. In cases where a marked divergence of opinion exists as to the value of a given method, or as to the inferences to be drawn from the results obtained by its employment, an attempt has been made to present fairly the two sides of the question, and references have in all cases been given, so that those interested may consult the original papers.

THE MICROSCOPICAL EXAMINATION AND ENUMERATION OF THE CELLULAR ELEMENTS OF THE BLOOD, AND THE ESTIMATION OF THE HAEMOGLOBIN

The investigations which come under this category, and which are usually included in the term *complete blood-count*, are as follows:

1. The enumeration of the red cells.

2. The estimation of the haemoglobin-percentage.

3. The enumeration of the leucocytes.

4. The estimation of the percentage of the various leucocytes present, usually known as the *differential count*. During this procedure we may detect the presence of certain leucocytes, such as myelocytes, which are not normally present in the peripheral blood.

5. The examination of the red cells to determine the presence or absence of abnormal types. Such variations from the normal include : (1) Changes in shape, the red cells becoming oval or pear-shaped, or showing the presence of one or more elongated processes. These abnormal cells are known as *poikilocytes* and the condition as *poikilocytosis*.

(2) Changes in size. Abnormally large or abnormally small cells may be present. The former are known as *macrocytes*, the latter as *microcytes*.

(3) Changes in staining reaction. The normal red cells take on with the various Romanowsky stains a fairly uniform pinkish-red tint, usually paling somewhat towards the centre. The two most important abnormalities which may occur are as follows : (a) Instead of taking up only the red or acid stain, the cells may also become coloured by the blue or basic stain. The result is that the cell stains a uniform purplish tinge. This condition is known as *polychromatophilia*. (b) The cells may be stained the normal colour, but may contain more or less numerous granules which take up the basic stain and become coloured a deep blue. This condition is known as *punctate basophilia*.

In addition to these marked changes in staining reaction, the cells in certain conditions become stained either more or less deeply than normal.

6. The presence of nucleated red cells. The peripheral blood in normal human adults contains no nucleated red cells. In certain conditions, however, these are often present and may be numerous. They are of two kinds : (a) *Normoblasts*. These cells are of approximately the normal size but contain a sharply-defined deeply-staining nucleus. The protoplasm of these cells usually takes on the normal eosin stain. (b) *Megaloblasts*. Here the cells are usually larger than normal, though this is not always the case. The nucleus is irregularly stained and usually shows a more or less definite chromatin network. The cell-protoplasm almost always shows a more or less marked degree of polychromatophilia and may contain basophilic granules.

The haemoglobin-percentage derives its chief importance from the varying relation it bears to the number of red cells present, considered as a percentage of the normal. This ratio—percentage of haemoglobin : percentage of red cells—is known

as the "Colour Index," and under normal conditions will of course approximate closely to unity. It shows well-marked variations in certain diseased conditions.

The following may be taken as normal results in the case of a healthy adult female patient :

Red cells	.	.	.	.	.	4,500,000 to 5,000,000 per cmm.
Haemoglobin	.	.	.	.	.	85 to 100 per cent.
Colour index	.	.	.	.	.	0.9 to 1.
Leucocytes	.	.	.	.	.	4000 to 10,000 per cmm.
Polymorphonuclear cells	.	.	.	.	.	60 to 70 per cent.
Lymphocytes	.	.	.	.	.	20 to 30 per cent.
Large hyaline cells	.	.	.	.	.	1 to 4 per cent.
Eosinophils	.	.	.	.	.	0.5 to 2 per cent.
Basophils	.	.	.	.	.	0.5 per cent or less.

The main conditions under which detailed examination of the blood along the above lines becomes of importance in gynaecological practice may now be considered.

ANAEMIAS

Anaemia is of interest to the gynaecologist mainly for the following reasons :

(1) It is often present in a more or less marked degree in certain cases of disturbed sexual functions. (2) It occurs with some frequency in women as the result of some form of haemorrhage, and must sometimes be differentiated from a true primary anaemia. (3) The exact degree of anaemia has sometimes to be considered in relation to the desirability of operative interference. (4) In certain primary blood-diseases haemorrhages from mucous surfaces, including uterine haemorrhages, may occasionally form a prominent symptom. Among these diseases lymphatic leukaemia is one of the most important.

It will suffice to indicate briefly the main points in the blood-pictures presented in the various conditions associated with marked anaemia.

Primary Anaemias.—(1) *Chlorosis*.—The red cells are diminished, but not usually to a very marked extent. They vary in most cases between three and four millions per cmm. Stained films show them to be smaller than normal, and they are often faintly stained, especially towards the centre. Poikilocytosis is often well marked but polychromatophilia and punctate basophilia are usually absent. Nucleated cells are infrequently present and never numerous. When present they almost always consist entirely of normoblasts. The haemoglobin is always much diminished, relatively much more so than the red cells, so that the colour index falls far below unity, usually giving a value between 0.3 and 0.6. A greater or less degree of leucopenia is always present. The white cells commonly number less

than 4000 per cmm., but rarely less than 2000. The lymphocytes are relatively increased at the expense of the polymorphonuclear cells, and a definite increase in the percentage of eosinophils is sometimes noticed.

(2) *Pernicious Anaemia*.—The red cells are greatly reduced. In a typical case they number between one and two millions per cmm. All types of abnormal cells are noted in stained films. The prevailing cell is rather larger than normal, and tends to stain more deeply. Poikilocytosis is usually well marked. Polychromatophilic cells are fairly numerous, and cells showing basophilic stippling are usually present. Nucleated red cells are present in greater or less number, and the megaloblasts tend to outnumber the normoblasts in a well-marked case. The haemoglobin is usually diminished, but generally to a less degree than the red cells, so that the colour index tends to approach or exceed unity. The leucocytes are almost always diminished, numbering between 1000 and 4000 per cmm. The polymorphonuclear cells are relatively decreased, and the lymphocytes correspondingly increased. A few myelocytes are sometimes present.

Secondary Anaemias.—(1) *Secondary Anaemia following Acute Haemorrhage*.—Immediately after profuse haemorrhage all the constituents of the blood, including the blood-fluids, are lowered to an equal degree. A blood-count taken at this period will therefore reveal nothing abnormal. Almost at once, however, the total blood-volume begins to increase again at the expense of body fluids, and, as there is no immediate corresponding regeneration of blood-cells, a count shows a steadily decreasing number of red cells per cmm. of peripheral blood. This decrease usually reaches its most marked degree from the first to the third day after the occurrence of the haemorrhage, when the red cells may number one million or less per cmm. in severe cases. The compensatory output of fresh red cells is not accompanied by an equally rapid output of haemoglobin, probably because immature cells first reach the circulation. Stained films prepared at this period show only slight poikilocytosis, but microcytes are numerous and polychromatophilia may be a marked feature, while punctate basophilia is less common. Nucleated red cells are usually present and may be very numerous. The normoblasts greatly outnumber the megaloblasts, except in very severe cases, and are usually the only type of nucleated red cell present.

As stated above, the haemoglobin percentage takes longer to assume its normal level than does the red-cell percentage. Hence the colour index is at first low and then gradually increases. During the days immediately succeeding the haemorrhage it tends to vary between 0.5 and 0.7.

There is a temporary leucocytosis rarely exceeding 20,000 per cmm., which comes on almost immediately after the haemorrhage, and may reach its height

within 12 hours. It sometimes persists for several days, but then rapidly decreases. It is accompanied by a considerable relative increase in the polymorphonuclear cells, though very occasionally a relative lymphocytosis has been recorded.

(2) *Secondary Anaemia from other Causes.*—It is impossible here to put forward any generalizations since everything depends on the causative condition. The red cells are usually only moderately diminished, but in rare cases may show a decrease comparable to that found in severe cases of pernicious anaemia. Poikilocytosis is more common than after acute haemorrhage, but polychromatophilia much less so. Nucleated red cells are usually scanty, and almost always consist entirely of normoblasts. Malignant growths with metastatic deposits in the bone-marrow may, however, yield blood-pictures of the most abnormal type. The haemoglobin is almost always more diminished than the red cells, and hence the colour index tends to fall below unity, and often approximates closely to a value of 0.7. The leucocytes are increased or decreased according to the primary condition. Save in those cases in which the anaemia is a part of, or secondary to, some form of leukaemia, the increase is not usually very great. Where a moderate leucocytosis is present, as in some cases of malignant disease, the polymorphonuclear cells are relatively increased. Where there is a leukopenia, as in many cachexias, there is usually a relative lymphocytosis. In cases in which the anaemia is the result of the presence of intestinal parasites, such as the various forms of tape-worm, there is a more or less marked eosinophilia.

KNOWN OR SUSPECTED INFLAMMATORY OR SUPPURATIVE LESIONS

In cases of this kind we are mainly concerned with the leucocytes, and the chief point is the presence or absence of the condition known as *leucocytosis*. This term in its usually accepted sense implies two conditions: an absolute increase in the number of white cells per cmm. of peripheral blood, and a relative increase in the number of polymorphonuclear cells. Thus in a typical case of leucocytosis the leucocytes might number 25,000 per cmm., and the polymorphonuclear cells account for 80 to 85 per cent of these. In order to appreciate correctly the diagnostic value which may be attached to a leucocyte-count, it is essential to remember the variations which may occur under physiological conditions. As stated above, the number of leucocytes per cmm. of peripheral blood may vary between 4000 and 10,000.

In order that we may attach the proper significance to any isolated observation, it is essential to have some idea of the normal leucocyte-count for the actual patient involved. It is only in ill-developed or ill-nourished patients that a count approxi-

minating to the lower of the two limits mentioned above could be considered normal ; but in a patient of this type a count of 10,000 leucocytes per cmm. would constitute a definite leucocytosis provided that the polymorphonuclear cells formed a relatively high percentage.

There are, however, certain periodic variations which occur in health. Thus, there is usually a post-prandial leucocytosis of a more or less marked degree following the mid-day meal, and in some apparently perfectly healthy subjects this increase may amount to 33 per cent. It has been shown that a leucocytosis is far less common after the morning and evening meals, and hence it is believed by some observers that this phenomenon represents a daily variation rather than the effect of digestion. It was long stated and believed that pregnancy was accompanied by an increase in the number of leucocytes present in the peripheral blood. Later observations (Zangemeister,¹ Hahl,² and Ascoli and Esdra³) have thrown grave doubts on this belief, and all tend to show that it is only with the actual onset of labour that a leucocytosis occurs. All observers agree that from the commencement of labour until delivery a definite leucocytosis exists. This continues during the first few days of the puerperium, usually disappearing about the end of the first week. According to some workers a fall in the number of leucocytes occurs immediately after delivery, followed by a secondary rise within a few days, but on this point there is not complete agreement. It will be seen therefore that the greatest care must be taken in interpreting the results of leucocyte-counts during the puerperium.

Other varieties of physiological leucocytosis, the leucocytosis of the new-born or that caused by cold baths or violent exercise, are not likely to constitute sources of difficulty in diagnosis, but certain other conditions which are known to give rise to this phenomenon must be excluded when it is employed for purposes of diagnosis in cases where suppuration is suspected. Thus most of the specific fevers (with certain well-marked exceptions, such as typhoid, influenza, and tuberculosis) are accompanied by leucocytosis. Malignant disease is often accompanied by this condition, though in some cases it is possible that the reaction is the result of inflammatory changes occurring in the new growth. A large number of observations have shown that following surgical operations, especially those involving laparotomy, there is a definite increase in the number of leucocytes lasting usually from two to five days, during which time they fall to the normal limit. The leucocytosis following severe haemorrhage has been referred to above.

Bearing these facts in mind we may turn to the consideration of the value of

¹ Zangemeister and Wagner, *Deutsche med. Wochenschr.*, 1902, vol. lxxxviii. p. 549.

² Hahl, *Arch. f. Gynäkol.*, 1902, vol. lxvi. p. 485.

³ Ascoli and Esdra, quoted by Hahl, *q.v.*

the leucocyte-count in conditions where we may suspect the presence of suppuration, as, for instance, in a suspected salpingitis. In any condition where there is acute inflammation, especially of the suppurative type, we usually find a more or less marked leucocytosis. The reaction may be absent, either when the inflammation is slight in character, or when the condition consists of a rapidly spreading and very severe infection accompanied by grave toxæmia. Thus, in a mild case of catarrhal appendicitis or in a severe case of spreading peritonitis due to the *streptococcus pyogenes*, no increase in the leucocytes may be found. It is in cases of slowly spreading suppurative lesions, such as a poorly localized appendix abscess, that the highest counts are obtained. A strictly localized suppurative lesion, such as a well walled-off abscess, usually gives rise to a high but stationary count. It is only by performing repeated counts that the full diagnostic value can usually be obtained. Thus, if such a condition as a tubal abscess is suspected, a high and increasing leucocyte count may be considered to yield definite proof of the presence of suppuration, and in general a persistently increasing leucocytosis in such a condition may be taken as indicating the need for surgical interference.

It must never be forgotten that all we can diagnose by this means is the presence of an acute inflammatory lesion somewhere in the body, and that we are never justified in interpreting it as a proof of any particular lesion being inflammatory in character, until we have excluded the presence of similar lesions elsewhere.

Apart from the actual increase in leucocytes and especially in polymorphonuclear cells, certain other changes may be noted in the blood in these conditions. These consist in the appearance of certain abnormal cells of the polymorphonuclear type, often known as *stimulation forms*, and in the presence of a particular staining reaction which indicates an increased amount of glycogen, mainly within the polymorphonuclear cells. Considerable importance is attached to this phenomenon by some observers as an aid to diagnosis.

Septicæmia.—In this condition the most important results are obtained by the *bacteriological* examination of the blood. This will be dealt with later. A large proportion of these cases, however, exhibit some degree of leucocytosis. In general it may be said that the higher the leucocytosis the better the prognosis, and patients suffering from a severe blood-infection leading rapidly to a fatal termination often exhibit no leucocytic reaction. The red cells in cases of this kind are usually much more affected than in suppurative or inflammatory lesions. A very marked reduction, down to 1,000,000 or less, sometimes occurs, and varying numbers of nucleated red cells, usually normoblasts, may be observed.

Other Conditions in which some Definite Alteration in the Leucocyte-count is known to occur

Leaving out of account the leukaemias, which hardly come within the scope of this article, the only conditions of importance in this category are those which induce an eosinophilia. The eosinophils in normal blood vary from 0.5 to 2 per cent, and anything above 4 per cent must be regarded as a definite excess, though very much higher percentages than this are often recorded. The conditions which are accompanied by a definite increase in the percentage of eosinophil cells in the peripheral blood are as follows :

- (1) Hydatid disease.
- (2) Infection with other animal parasites, *e.g.* tape-worms.
- (3) Asthma.
- (4) Certain skin-lesions, especially pemphigus, dermatitis herpetiformis, and urticaria.
- (5) Some cases of gonorrhoea.
- (6) Certain post-febrile conditions.
- (7) Some cases of malignant disease.
- (8) Occasionally after haemorrhage.
- (9) Some cases of osteomyelitis, osteomalacia, and bone-tumours.

(10) According to some authorities the eosinophils are increased in all forms of disease of the female genital organs. This has, however, been denied. Voswinckel,¹ quoted by Cabot,² states as a result of examination of 126 cases of pelvic disease that all cases of severe ovarian disease, excepting cancer and cases associated with fever, exhibit a more or less marked degree of eosinophilia, while disease of the Fallopian tubes and fibromyomata of the uterus show none. He finds that in carcinoma of the uterus the eosinophils may be normal, increased, or absent.

The eosinophilia present in many of the above conditions is only slight, and is moreover observed only in a proportion of the cases included under any one heading. In hydatid disease, however, and in various forms of helminthiasis, high counts from 16 to 70 per cent and more have been recorded. In practice the phenomenon is of most use in the diagnosis of these parasitic infections, and it is only necessary to bear in mind the other causes of eosinophilia when interpreting the results.

¹ Voswinckel, *Monatsschr. f. Geburtsh. u. Gynäkol.*, 1898, vol. vii. p. 413.

² Cabot, *The Clinical Examination of the Blood*, New York, 1904.

THE BACTERIOLOGICAL EXAMINATION OF THE BLOOD

The preparation of cultures direct from the systemic blood-stream sometimes affords valuable information. It is essential to take a considerable quantity of blood (about 10 c.c.), and this is best obtained from the median-basilic vein of the arm by simple puncture with a suitable hypodermic needle or by careful aspiration with a syringe. The strictest asepsis must of course be observed throughout, and it is necessary to have suitable culture-media at hand. The operation is usually carried out by the bacteriologist. It must be remembered that incubation for seventy-two hours is necessary before the cultures can be pronounced sterile, and a further period may be necessary in order satisfactorily to establish the identity of the organisms present.

The value of the examination rests on the fact that the occurrence of a bacterial growth in such a culture establishes both the presence of a septicaemic infection and the identity of the infecting organism, thus indicating the appropriate treatment in certain cases. Failure to obtain a growth cannot, however, be held to exclude septicaemia in the clinical sense of the term, probably because the distribution of organisms in the general circulation varies much from time to time, and very large numbers are seldom present except immediately *ante mortem*.

THE SEROLOGICAL EXAMINATION OF THE BLOOD

Agglutination.—The presence of specific agglutinins in the blood-serum affords a method of testing for the presence of infection with a given organism. The diseases in which this method has received its most useful application are typhoid fever and Malta fever. The reaction will not concern the gynaecologist, save for the purpose of a differential diagnosis. It should be remembered that in typhoid fever the agglutinins are often not developed until the second week of the disease, and that during the first seven days or so a blood-culture affords a much better method of establishing a diagnosis. From this time onwards until the subsidence of the fever, and often during the early part of convalescence, the agglutination reaction is the best method at our disposal for determining the presence of an infection with the *b. typhosus*. A point which is sometimes of importance is that a prophylactic inoculation of anti-typhoid vaccine tends to produce agglutinins in the blood-serum which may persist for months or even years, and so invalidate the results obtained by this method.

Phagocytosis.—The phenomenon of phagocytosis, or the ingestion of micro-organisms by the leucocytes, especially the polymorphonuclear cells, has been the subject of continual investigations. The investigations of Wright¹ and his co-workers

¹ Wright, *Studies in Immunisation*, London, 1909.

have shown that the serum contains some substance or substances which are essential to the occurrence of phagocytosis, and, further, that the serum acts upon the bacteria, preparing them in some way for ingestion by the leucocytes. To the substances in the serum which possess the latter property Wright gave the name of *opsonins*. A method for diagnosing infection with a given organism based upon this phenomenon has been evolved and has been in general use for a considerable period. The method employed is to prepare a mixture of the serum of the patient, normal human leucocytes, and a saline suspension of the organism which is suspected to be the cause of the disease. A similar mixture is put up in which the patient's serum is replaced either by a known normal serum or by a sample obtained by mixing the sera of several normal subjects. Incubation is then carried out at 37° C. for a definite period, films are prepared and stained, and the number of organisms ingested by a definite number of leucocytes, usually 50, is determined in each case. The number of organisms ingested in the case where the patient's serum is employed is divided by the number ingested when this is replaced by normal serum, and the fraction obtained is known as the *opsonic index*. In cases where the organism examined is not the cause of infection, the index is supposed to approximate closely to unity, while a wide departure from an index of 1 in either direction is supposed to indicate the presence of an infection with the organism examined.

The general results of an extended trial of this method and of many modifications, which have from time to time been adopted, indicate that the variations caused by slight differences of technique, or by conditions of the patient quite other than those due to a specific infection, are so wide that little reliance can be placed on this reaction from a diagnostic point of view, and it has largely fallen into disuse.

The opsonic index has also been largely employed as a method of controlling treatment with vaccines prepared from various organisms. The experience of a large number of workers has led to a very general belief that the clinical condition of the patient affords a much better criterion for this purpose. The chief value of the fresh light which has been shed on the phenomenon of phagocytosis, as the result of the work of Wright and his colleagues, would seem to lie in the purely experimental field, and here its value has been enormous.

Complement-Fixation.—To understand the principles which underlie this phenomenon, it is essential to have some idea of the steps by which we have arrived at our present knowledge of the factors involved. The demonstration by Pfeiffer¹ in 1894 of the destruction and solution of cholera vibrios in the peritoneum of an *immunized guinea-pig* may be taken as marking the first stage. It was subsequently

¹ Pfeiffer, *Zeit. f. Hygiene*, 1894, vol. xviii. p. 1.

shown by Metchnikoff¹ that the guinea-pig blood-serum possessed similar properties, and later Bordet² demonstrated that while the serum loses its power after being kept for some days in the laboratory, or after being heated for thirty minutes at 55° C., it can be reactivated by the addition of a little fresh serum, from either an immune or a normal guinea-pig. He thus demonstrated that two substances are necessary for the production of bacteriolysis. One is the active substance called *alexine*. This is present to a greater or less extent in all sera, normal or immune, but loses its activity if heated beyond a certain point. The other substance, which he named the *sensitizing substance*, is only present in the serum of certain animals, but can be produced as the result of immunization in the serum of many others which do not possess it naturally. It is thermostable, *i.e.* it remains unaltered after being heated for thirty minutes at 55° C. Bordet showed that the same facts held true for red blood-corpuscles. Thus, certain sera have the power of lysing certain red cells: human sera, for instance, will cause haemolysis of sheep corpuscles. By injecting the red cells of an animal of one species into an animal of another it is possible to produce a serum which has very powerful haemolytic properties. In both cases the lytic power depends on the presence, natural or acquired, of the sensitizing substance, which enables the active substance to combine with the red cells and then produce lysis.

As a result of the investigations of Ehrlich³ and his co-workers, new terms have been introduced into the nomenclature, and it is usual in this country to speak of the active substance as *complement* and of the sensitizing substance as the *amboceptor* or sometimes the *immune body* or *antibody*. It will be seen that these facts supply a test for the presence of complement in any serum or other suitable fluid. If we add to such a fluid red cells and a haemolytic antibody for those cells, then we have two of the factors necessary for the production of haemolysis; and if the fluid contains complement, then we have all three factors present, and haemolysis will result under suitable conditions (*i.e.* after incubation for a certain time at body temperature), producing a clear fluid tinged with haemoglobin. If, however, the fluid contains no complement, then no lysis will occur, and the red cells will gradually settle to the bottom of the experimental tube, leaving a colourless supernatant fluid.

It was shown by Bordet and Gengou⁴ that certain organisms when mixed with the serum of an animal immunized against them had the power of absorbing

¹ Metchnikoff, *Immunity in Infective Diseases*, translated by Binnie. Cambridge University Press, 1907.

² Bordet, *Annales de l'Inst. Pasteur*, 1898, vol. xii. p. 688.

³ Ehrlich, *Studies in Immunity*, English Translation by Bolduan, New York, 1910.

⁴ Bordet and Gengou, *Annales de l'Inst. Pasteur*, 1901, vol. xv. p. 290.

complement. This absorption is evidenced by the subsequent addition of a mixture of red cells and haemolytic antibody with failure of haemolysis. These observations led to a large number of investigations, having as their object the clinical application of the phenomenon for diagnostic purposes. In all these investigations the method has consisted in bringing together the serum of a patient suffering from a given disease, which serum may be supposed to possess an antibody, and the causal organism of the disease, or the nearest possible approach to it, against which the antibody may be supposed to act. Any substance which upon obtaining entrance into a living organism gives rise to the formation of an antibody is known as an *antigen*; and a great part of the difficulty in applying tests of this kind lies in the finding of a suitable antigen by which to demonstrate the presence of the antibodies which exist in the serum.

The Wassermann Reaction.—In the case of syphilis the difficulty of finding a suitable antigen, since the *spirochaeta pallida* had not then been cultivated, was met by Wassermann in conjunction with Neisser and Bruck,¹ who utilized extracts of organs infected with syphilis, especially the livers of syphilitic foetuses which are known to contain large numbers of spirochaetes. The sera of the great majority of patients suffering from clinically-obvious syphilis, when mixed with this antigen, produced well-marked fixation of complement, while this phenomenon never occurred with normal controls in whom syphilis could be excluded, or in patients suffering from other diseases. It was soon discovered, however, that extracts of normal liver or of normal heart-muscle, or solutions of lecithin or cholesterin, indeed a large number of substances of a lipid nature, gave identical results. It thus became clear that the Wassermann reaction is not a true immunity-reaction, for the liver- or heart-extract, or lecithin-cholesterin solution, is not a true antigen, though it is always spoken of as an antigen for convenience. All we can say in the present state of our knowledge is that the serum of a syphilitic patient has in it in the great majority of cases some body which reacts with various lipid substances in such a way as to cause the absorption of complement, possibly as a result of the changes which occur in the early stages of precipitation. In any case there is no valid theoretical reason why this peculiarity should be confined to syphilitic sera, and it became doubly important to determine whether such was indeed the case.

As the result of an enormous number of tests, covering almost every known disease and endless normal controls, it has been shown that the reaction occurs in leprosy as well as in syphilis, and occasionally in sleeping sickness, scarlet fever, frambroesia, malaria fever during the crisis, beri-beri, and eclampsia. As regards

¹ Wassermann, Neisser, and Bruck, *Deutsche med. Wochenschr.*, 1906, vol. xxxii. p. 745.

most of these conditions the evidence is conflicting, and although some observers report a proportion of positive results, others have failed to obtain them. All these conditions are usually susceptible of clinical elimination, and in their absence a positive Wassermann reaction may be accepted as conclusive proof of a syphilitic infection.

Technique.—The technique of the original reaction is broadly as follows. The serum of the patient is heated for thirty minutes at 55°C. , in order to destroy the complement which is normally present. Fresh complement is introduced by adding a definite quantity of fresh guinea-pig serum to each tube of the test or series of tests. This is done to ensure that every tube shall have an equal amount of complement, since the amount present is subject to variation. The antigen employed is added in a definite strength previously determined by titration with specimens of normal and syphilitic sera. The actual amount employed must give complete fixation with a syphilitic serum, and be less than half the amount which will fix complement alone or in the presence of normal serum. This is a matter of considerable importance, since the antigens employed will alone fix complement if in sufficient strength. Finally, a suspension of red blood-cells is required and a specific haemolysin which has been prepared by the inoculation of a suitable animal. This haemolytic serum is employed in a dilution containing four times the amount necessary to cause complete haemolysis. The actual test consists of a tube containing the patient's serum, antigen, and complement. Control tubes are set up containing (1) patient's serum and complement, the antigen being replaced by saline, (2) antigen and complement, the serum being replaced by saline, (3) a known syphilitic serum with antigen and complement, and (4) a known normal serum with antigen and complement. It is very desirable to put up a tube containing twice the amount of antigen used in the actual test together with complement. The whole series is incubated for one hour at 37°C. , and then the required amount of red cells and haemolysin are added to each tube, and incubation is proceeded with for another hour. The tubes are then examined and, if necessary, allowed to stand overnight on ice and examined again. The tube containing the known syphilitic serum must show no haemolysis: that is, at the end of the first hour there will be little change, while later the red cells will gradually be deposited leaving a colourless supernatant fluid. The other control tubes must show a clear red fluid at the end of the first hour indicating complete haemolysis.

We then know that under the actual conditions of the experiment a mixture of syphilitic serum and antigen completely fixes complement during the first hour's incubation, while neither does so alone.

The actual test is then examined, and if no haemolysis has occurred the reaction is regarded as positive, since fixation of complement has taken place, and hence we may deduce that the substance reacting with the lipid antigen was present in the serum. If, however, haemolysis is complete, the reaction is negative.

Modifications of the Original Technique.—Wassermann's original technique has, however, been considerably modified by various subsequent workers, and this has led to the introduction of several different methods of performing the reaction. In some cases the only factor altered has been the antigen. As stated above, the test was originally carried out with a watery extract of the liver of a syphilitic foetus, but later investigations all tend to show that the presence of the *spirochaeta pallida* is a factor of no importance, while the essential constituent is a lipid substance. The result has been that alcoholic extracts of normal liver- or heart-muscle, solutions of lecithin, or any of the above extracts with the addition of cholesterin, have largely supplanted the original Wassermann antigen, and all available statistics tend to show that satisfactory results are obtained with any of these substances. Other modifications, however, have been introduced, the purpose of which has been to simplify the technique, and it is in regard to these that criticism has been active. One of the most important of these modifications is that which was originally described by Hecht,¹ and which has been introduced into this country by Fleming² with slight modifications. The main points of difference between the test and the original Wassermann reaction are as follows. The serum to be tested is not inactivated by heat, and the native complement and also the haemolysin for sheep corpuscles, which is usually present in human serum, are utilized in the test. The only reagents required in addition to the patient's serum are, therefore, the antigen and sheep corpuscles.

Objections have been raised to this modification on the ground that both the amount of complement and the amount of haemolysin vary in different specimens of normal human serum, and hence it is impossible accurately to standardize the reagents. The most serious objection which has been advanced is that, in the presence of an unusually small amount of complement or haemolysin, it may be possible for haemolysis to occur in the control tube which contains no antigen, while, in the presence of this substance, an inhibitory effect may be produced which is just sufficient to cause failure of haemolysis, and hence to simulate a positive reaction.

Other serious objections are that a certain number of sera are found which are so deficient in either complement or haemolysin that it is impossible to carry out the modified test without the addition of further serum from a normal source:

¹ Hecht, *Wien. klin. Wochenschr.*, 1908, vol. xxi. p. 1742.

² Fleming, *The Lancet*, 1909, vol. i. p. 1512.

a method which is not without objection. Again, it has become customary in many laboratories to attempt a quantitative estimation of the strength of the reaction, and this is done in the original test by graduating the amount of the patient's serum. In Fleming's modification, quantitative results are made by varying the amount of the antigen, and for various theoretical reasons, which need not be entered into here, this is a much less satisfactory method.

A further point of importance is that the original method, or one closely resembling it in all important details, is carried out in the great majority of laboratories where this test is employed, and hence by far the greater part of the statistics at our disposal for judging the exact significance of the reaction are based on the original method. The only real advantage of the modified method would seem to consist in the fact that the unheated serum tends to give a stronger reaction than the heated, and hence a positive reaction is sometimes obtained with the former and not with the latter. This is, however, a somewhat doubtful advantage, as it is possible, though it cannot by any means be considered as certain, that the heating increases the specificity of the test. In any case the more complicated technique allows of so much more accurate standardization of the reagents, and of so much more accurate quantitative results, that it must be considered to be greatly superior to the simpler method.

The Diagnostic Value of the Reaction.—In early primary syphilis, that is the period elapsing between the appearance of the chancre and the advent of glandular enlargement, the Wassermann reaction, although positive in a considerable proportion of cases, is often negative. Fortunately, we possess in the demonstration of the presence of the specific organism¹ a much more certain and satisfactory method of diagnosis at this stage of the disease. From this time onward and throughout the secondary stage the reaction is almost always positive *in untreated cases*, so much so that a negative reaction almost excludes the possibility of syphilis in a case which clinically presents features which lead to a provisional diagnosis of the disease in this stage. In suspected tertiary lesions the reaction, though usually positive, is not always so; so that, while a negative reaction should always lead to a careful reconsideration of the diagnosis, it cannot be held to exclude syphilis in the presence of strong clinical evidence of the disease.

In later syphilitic manifestations the percentage of positive reactions varies, though in two at least, aneurysm and general paralysis of the insane, it is as high as at any stage of infection.

A point of great importance is the reliability of the reaction in cases in which

¹ *Vide* pp. 117 and 681.

there is no clinical evidence of syphilitic infection. In view of the enormous mass of statistics which we now have at our disposal, we are justified in saying that the occurrence of a positive reaction, as shown by the original technique, is conclusive proof of syphilitic infection when the few conditions mentioned above can be excluded. A point in this connection which especially concerns the gynaecologist is the frequency of occurrence of a positive reaction in women who, while to all appearances normal, have given birth to syphilitic children. Knöpfelmacher and Lehendorff¹ found a positive reaction in 65.2 per cent of 135 mothers with syphilitic children, though the majority of these yielded no clinical evidence of the disease. Stroscher² found a positive reaction in every case of this kind which he examined. Mulzer and Michaelis³ found a positive reaction in 83 per cent of similar cases.

The Effect of Treatment on the Reaction.—The result of energetic antisyphilitic treatment, either by salvarsan or mercury, is in the great majority of cases to turn a positive reaction into a negative one. It usually requires some weeks, often several months, for this to occur, and it is almost always found that, if the treatment be discontinued as soon as the reaction becomes negative, a positive reaction is again obtained within a few weeks or months. If, however, the treatment has been energetic and prolonged, the reaction usually becomes negative and remains so for many months or years. It is of course impossible to dogmatize on this point, since the reaction was only introduced eight years ago, and its general employment dates from even a shorter period. Our knowledge, however, is quite sufficient for us to state that in the large majority of cases, in which a full and regular course of treatment has been undergone, a negative reaction usually persists for many years, together with the absence of all clinical manifestations.

Where the test is employed to control treatment, and there is not the least doubt of its great utility in this respect, at least three months should be allowed to elapse between the cessation of the treatment and the performance of the test. It is advisable to repeat the reaction after a further interval of several months during which no treatment has been administered.

All the knowledge at our disposal points to a positive reaction being evidence of the existence of actual syphilitic infection. There is no reason, either theoretical or practical, for regarding it as evidence of a form of immunity. A patient who has been satisfactorily treated and some years afterwards shows no evidence of disease gives in the great majority of cases a negative reaction. A patient who exhibits a

¹ Knöpfelmacher and Lehendorff, *Jahrb. f. Kinderheilk.*, 1910, vol. lxxi. p. 156.

² Stroscher, *Derm. Zeitschr. Wiesb.*, 1910, vol. xvi. p. 485.

³ Mulzer and Michaelis, *Berl. klin. Wochenschr.*, 1910, vol. xlvii. p. 1402.

late syphilitic lesion usually gives a positive one. In some cases the change of the reaction from negative to positive has preceded the appearance of a clinically manifest lesion.

The effect of treatment must never be overlooked when using the reaction for diagnostic purposes. If a doubtful case of early syphilis has already received anti-syphilitic treatment, no reliance can be placed on a negative result.

The Collection of the Blood.—In obtaining blood for this test it is advisable to take a quantity of not less than 2 c.c. This amount or more may be easily obtained from the median-basilic vein of the forearm, either with a syringe or by inserting a suitable hypodermic needle into the vein. A tourniquet should be applied to the arm above the elbow, and the strictest aseptic precautions must of course be employed.

There is no difficulty in obtaining this amount of blood by simple puncture of the terminal part of the thumb, if a good triangular surgical needle be employed. A piece of rubber tubing is utilized as a tourniquet round the base of the thumb, and the patient is made to produce some degree of venous congestion by vigorously swinging the arm from the shoulder. It is necessary to unwind and reapply the tourniquet several times, the patient swinging the arm in the intervals, but a single puncture usually suffices. The blood should be dealt with within twenty-four hours of collection and it is essential to avoid gross bacterial contamination.

The Complement-Fixation Reaction in Tuberculosis.—Many attempts have been made to devise a method which might render this reaction of use in the diagnosis of infection with the *b. tuberculosis*. The main difficulty has been to produce a suitable antigen. Various forms of tuberculin, saline emulsions, or alcoholic extracts of the *b. tuberculosis*, and cultures prepared on special media have all been employed for this purpose.

None of the various methods devised has as yet been applied to a sufficiently large number of cases for us to be in a position to form a definite opinion as to its clinical value. Such evidence as we possess points to the test being of considerable service in diagnosing certain cases of pulmonary tuberculosis, but the results with the various forms of surgical tuberculosis have not been quite so encouraging, and it is certain that a negative reaction is of very little significance. The antigen employed in some of the methods gives a positive reaction with a certain proportion of syphilitic sera, probably because it contains substances of a lipoid nature. It is necessary under these circumstances to control the test by means of a Wassermann reaction.

It may well be that future developments in technique will lead to results possessing a greater diagnostic value. In view of the highly unsatisfactory nature of the

various immunity tests, which are at present at our disposal for the diagnosis of such a widespread and important disease as tuberculosis, such a development is greatly to be desired.

The Complement-Fixation Reaction in Malignant Disease.—The results obtained in cases of carcinoma and sarcoma have been very conflicting. Though some workers claim to have obtained excellent results, others regard the test as having no clinical value. Here again one of the main difficulties seems to be the selection of a suitable antigen.

The Complement-Fixation Reaction in various Bacterial Infections.¹—It is possible by this method to demonstrate infection by many different micro-organisms, for instance by the *b. typhosus*, though here the development of agglutinins in the serum affords a readier method of diagnosis. Attempts have been made to apply this reaction to the diagnosis of infection by certain pyogenic organisms, notably by the gonococcus. Here again the success obtained by different workers has varied considerably, and the method cannot yet be regarded as possessing sufficient certainty to be used with safety for clinical diagnosis.

To render this test reliable from a clinical standpoint, it is essential to show that the sera obtained from a large number of patients suffering from a certain disease, produce in the presence of a suitable antigen a degree of complement-fixation which is greatly in excess of that produced by the sera of a large number of normal and abnormal controls, acting together with the same antigen, and also greatly in excess of the degree of fixation produced by the antigen alone. Conclusions which depend on the observation of only small differences, or which are based on the examination of only a few cases, or which do not consider the results obtained in a sufficiently large number of normal and abnormal controls, cannot be safely applied in clinical diagnosis.

The Complement-Fixation Reaction in Hydatid Disease.—In infections with the *taenia echinococcus*, which result in the formation of hydatid cysts, there is developed in the blood-serum an immune body which fixes complement in the presence of the fluid obtained from such a cyst. This reaction has been widely used in those parts of the world where hydatid disease is common, and has yielded excellent results.¹ It is necessary to use sterile hydatid fluid as the antigen. A saline extract prepared from the ground-up cyst-wall has been employed as a substitute, but the results are far less satisfactory. The technique is identical with that employed in the Wassermann reaction.

¹ This matter is also referred to in the Article on Streptothrix Infections (p. 695).—EDITORS.

PROTEOLYTIC FERMENTS IN THE BLOOD

The work of Abderhalden¹ and his colleagues has recently aroused widespread interest in the investigation of the various proteolytic ferments which may occur in the peripheral blood. Out of these investigations have developed certain diagnostic reactions which aim at detecting the presence of various conditions by demonstrating the existence in the serum of specific ferments acting upon particular proteid substrates.

The most widely investigated of these reactions is that which is said to occur when the serum of a pregnant woman is allowed to act on specially prepared placental tissue. The application of Abderhalden's work would, however, extend far beyond the possible diagnosis of pregnancy if his facts were substantiated and the deductions he makes from them were proved to be correct. His whole theory is based on the supposition that, when any proteid substance which is "out of harmony" with the blood, or with any given tissue, gains access to the blood or to that tissue, a reaction follows which results in the production of a specific ferment, which so acts upon the protein as to break it down into substances which are "harmonious" with the tissue involved. These conditions may be brought about experimentally by the injection of a foreign protein. Abderhalden believes that they are brought about in the living subject during various pathological or physiological processes. Thus, in pregnancy it has been shown that chorionic epithelium enters the circulation, and this fact would be sufficient to give rise to specific ferments directed against these cells. This, however, is not, according to Abderhalden, the only explanation, since he states that the blood-serum of the mare contains during pregnancy defensive ferments directed against placental albumen; yet the anatomical relations of the placenta in this animal exclude the possibility of chorionic cells entering the general bloodstream.

In pathological conditions involving infection by specific bacteria, or the rapid proliferation or degeneration of any given tissue, Abderhalden believes that specific ferments are produced, directed against the special substances involved. Thus he considers that it should be possible to detect infection with a given organism by demonstrating the presence of ferments directed against it, or a pathological condition of any one organ, such as the thyroid gland, by demonstrating the presence of specific ferments acting on the particular tissue involved. It is obvious that the success of any reaction of this kind will depend upon the strict specificity of the

¹ Abderhalden, *Abwehrfermente*, 4th edition, Berlin, 1914; and *Defensive Ferments of the Animal Organism* (translated from the third German edition by Gavronksi and Lancheester. London, 1914).

ferments produced, and to this point we shall return later when discussing the results that have been obtained by various workers.

The great majority of the investigations which have so far been undertaken relate to the diagnosis of pregnancy, and Abderhalden himself lays particular stress on this reaction as establishing the validity of his results. The principles involved and the methods employed are identical for this and every other test of the same kind ; but it should be remembered that, were the accuracy of the results established, far wider fields of investigation would be opened up, and in particular it might be possible to diagnose such conditions as carcinoma or other malignant growths. Indeed no limits would seem to be set to the possible usefulness of this method by its most ardent supporters.

As regards the pregnancy-reaction, which may perhaps be said to concern most closely the gynaecologist, it is stated that this condition may be established as early as the eighth day of pregnancy. The clinical value of this would seem to be small, since there must very seldom be any reason for establishing a diagnosis at so early a period, and at later periods, when a patient herself suspects pregnancy, the gynaecologist can confirm or exclude the presence of the condition by clinical examination. The clinical uses of the test would seem rather to lie in the possibility of diagnosing a tubal gestation, the presence of retained products after parturition, or chorion-epithelioma, since all these conditions are said to give a positive reaction.

The test may be applied in two ways, the *optical method* and the *dialysation method*. In the former method placental peptones are prepared from the human placenta, and the serum to be tested is allowed to act on these substances, their further cleavage into amino-acids being detected by observing alterations in the angle of deviation by means of a specially constructed polarimeter.

In the dialysation method the serum is allowed to act on placental albumen, the mixture being placed in a special dialysation thimble and surrounded with distilled water. The thimble is of such a nature that under these circumstances albumens are retained within it, while as soon as peptones are produced these dialyse out into the surrounding medium. After a definite interval the dialysate is tested for the presence of peptones by a special reagent known as *ninhydrin*.

The greatest stress is laid by Abderhalden and his colleagues on absolute accuracy of technique, and this involves a large amount of preliminary testing of reagents and apparatus, especially the dialysation tubes. About 10 c.c. of blood is required, and this must be withdrawn under the strictest aseptic precautions, and the serum must show no tinge of haemolysis. Sufficient controls must of course be put up in all cases.

In attempting to estimate the value of Abderhalden's methods in clinical diagnosis, one is met with the difficulty that the general employment of the reaction is too recent, and the results so far obtained are too contradictory to make any final pronouncement possible. At this stage the most that can be done is to present a summary of the results recorded by various workers, and to indicate as far as possible their significance.

It must be stated at the outset that the most bewildering discrepancies exist between the conclusions of the various investigators who have employed this test. Several record 100 per cent of correct diagnoses; many others, of equal eminence, regard the reaction as entirely valueless.

Some of the confusion has perhaps arisen from the existence of two separate methods. Thus, some workers have employed the optical method alone, many the dialysation method alone, and some have controlled the one method by the other. Some of those who rely mainly on the optical method, and record good results by its use, state that only in this way can reliable indications be obtained, and suggest that observations based on the dialysation method alone should be disregarded. Abderhalden himself, however, obtains almost complete agreement between the findings given by the two methods. So certain does he seem of their absolute reliability, that he gives it as his opinion that no worker should investigate pathological conditions by either method until he can produce 100 per cent of correct results when dealing with the sera of pregnant and non-pregnant women, and using placental tissue as a substrate.

The communications which have appeared dealing with this reaction already number several hundreds, and it is hence impossible to give in detail the results obtained. Attention must, however, be called to a few of the more important criticisms.

Michaelis and von Lagemarek,¹ after employing the dialysation method in a large number of cases, adhering in every particular to Abderhalden's technique, and employing in addition a modified method of their own, failed to obtain evidence that the serum of pregnant women differed in any recognizable way from the serum of non-pregnant controls or from serum obtained from the male. They employed normal individuals as their controls in the majority of cases. Abderhalden² answered this criticism mainly by complaining that the optical method was not employed in addition to the dialysation method, and by criticizing in his turn the modification employed by Michaelis and von Lagemarek. Michaelis³ in a further note replies to

¹ Michaelis and von Lagemarek, *Deutsche med. Wochenschr.*, 1914, vol. xl. p. 316.

² Abderhalden, *Deutsche med. Wochenschr.*, 1914, vol. xl. p. 428.

³ Michaelis, *Deutsche med. Wochenschr.*, 1914, vol. xl. p. 429.

Abderhalden's strictures on his modified reaction, but points out that they have really no bearing on the question, since in every case Abderhalden's dialysation method was carried out in addition, and the technique described by him minutely adhered to.

The results obtained by those workers who have employed the optical method show almost as marked variations. Abderhalden himself, in a communication published in conjunction with Freund and Pincussohn,¹ records numerous failures to obtain a positive reaction in cases of pregnancy. He considers that these results are due to faulty peptone preparations employed by Freund and Pincussohn, and states that he has himself never failed to obtain a correct result.

Aschner² obtained 18 incorrect results in 120 observations consisting of 61 pregnant cases and 59 controls. Wallis, whose paper contains an excellent review of the literature,³ reports uniformly correct results. Gavronsky, whose work will be referred to again, considers that there is no evidence of specificity in the results obtained.

In those cases where the dialysation method has been relied on the results are, as indicated above, extraordinarily divergent; but even those workers who report favourably on the method often record 10 per cent or more of errors, and these errors consist in false positive results as well as false negative.

As mentioned above the value of such a test must depend on the strict specificity of the ferments involved, and it is around this question that much of the controversy centres.

Behne,⁴ Englehorn,⁵ Heilner and Petri,⁶ Lindig,⁷ Parsamow,⁸ Schmid,⁹ Marcus,¹⁰ Williams and Pearce,¹¹ Leitch,¹² Falls,¹³ Echols,¹⁴ Oeller and Stephan,¹⁵ Gavronsky¹⁶ and others have published results showing that the serum of patients suffering from various pathological conditions, especially carcinoma, syphilis, and certain inflam-

¹ Abderhalden, Freund, and Pincussohn, *Prakt. Ergebn. d. Geb. u. Gynäk.*, 1910, Jahrg. 5, Abt. xi. p. 367.

² Aschner, *Berl. klin. Wochenschr.*, 1913, vol. l. p. 1243.

³ Wallis, *Journ. Obstet. and Gynaec. Brit. Empire*, 1914, vol. xxv. p. 53.

⁴ Behne, *Centralbl. f. Gynäk.*, 1913, vol. xxxvii. p. 613.

⁵ Englehorn, *Münch. med. Wochenschr.*, 1913, vol. lx. p. 587.

⁶ Heilner and Petri, *Münch. med. Wochenschr.*, 1913, vol. lx. p. 1530.

⁷ Lindig, *Münch. med. Wochenschr.*, 1913, vol. lx. p. 288.

⁸ Parsamow, *Zentralbl. f. Gynäk.*, 1913, vol. xxxvii. p. 934.

⁹ Schmid, *Prag. med. Wochenschr.*, 1913, vol. xxxviii. p. 541.

¹⁰ Marcus, *Berl. klin. Wochenschr.*, 1913, vol. l. p. 776.

¹¹ Williams and Pearce, *Surgery, Gynaecology, and Obstetrics*, 1913, vol. xvi. p. 411.

¹² Leitch, *Brit. Med. Journ.*, 1914, vol. ii. p. 161.

¹³ Falls, *Journ. Amer. Med. Assoc.*, 1914, vol. lxiii. p. 1172.

¹⁴ Echols, *Journ. Amer. Med. Assoc.*, 1914, vol. lxiii. p. 370.

¹⁵ Oeller and Stephan, *Münch. med. Wochenschr.*, 1914, vol. lxi. p. 75.

¹⁶ Gavronsky, *The Lancet*, 1915, vol. i. p. 119.

matory conditions, will cause the proteolysis of placental tissue, while the serum of pregnant women will break down other than placental tissues. Gavronsky's publication is of especial interest, since he examined sera from a large number of patients suffering from various conditions, and allowed them to act on many different tissues. He employed both the optical and dialysation tests.

Bullock, as the result of a large number of animal experiments and some observations on the human subject, fails to find any support for Abderhalden's methods as a means of clinical diagnosis, or to obtain any confirmation of the experimental results on which his whole theory is based.

On the other hand, Abderhalden himself, Heimann,¹ Ekler,² Epstein,³ Jaworski and Szymanowski,⁴ Judd,⁵ Schwartz,⁶ Wallis and others maintain that the test is strictly specific.

A certain discrepancy exists also as regards the relative reliability of a negative and positive result. Wallis⁷ and also Bolaffo⁸ state that greater stress should be laid on a positive than on a negative reaction, whereas the majority of those who have called attention to this point regard a negative result as having more value in excluding pregnancy than a positive result has in establishing its presence.

A careful examination of the literature reveals certain points of interest. It is impossible to avoid noticing how ready the supporters of the method are to attribute every kind of error to those who obtain incorrect results. The materials employed and the workers who employ them are suspected with almost equal frequency. No reaction will ever be generally useful in clinical diagnosis while it can only be performed by an elect few. It is essential that it should yield uniform results in the hands of at least the great majority of experienced laboratory workers, and it is absurd to attribute either inexperience or incompetence to many of those who have reported unfavourably on the test.

Again it will be found in general, as Gavronsky emphasizes, that the larger the series of cases investigated, and the more numerous the control non-pregnant cases in which some definite pathological lesion is present, the higher will be the percentage of erroneous results.

Why it is that many investigators of repute have obtained uniformly correct

¹ Heimann, *Münch. med. Wochenschr.*, 1913, vol. lx. p. 915.

² Ekler, *Wien. klin. Wochenschr.*, 1913, vol. xxvi. p. 696.

³ Epstein, *Wien. klin. Wochenschr.*, 1913, vol. xxvi. p. 649.

⁴ Jaworski and Szymanowski, *Wien. klin. Wochenschr.*, 1913, vol. xxvi. p. 922.

⁵ Judd, *Journ. Amer. Med. Assoc.*, 1913, vol. lx. p. 194.

⁶ Schwartz, *Journ. Amer. Med. Assoc.*, 1913, vol. lxi. p. 434.

⁷ Wallis, *Journ. Obstet. and Gynaec. Brit. Emp.*, 1914, vol. xxv. p. 53.

⁸ Bolaffo, *Pathologica*, 1913, vol. v. No. 2, p. 352.

results, while many others have found the test almost valueless, we are not yet in a position to understand. Only the future will show on which side the truth lies, but, in view of the extremely discordant results so far obtained, it would seem that the clinician must await further developments before placing reliance on the test as a diagnostic method.

ANTI-FERMENTS AND SUBSTANCES WHICH ACCELERATE FERMENT ACTION

It has been pointed out by several investigators, Marcus,¹ Brieger and Trebbing,² Shaw-Mackenzie³ and others, that the normal power which human blood-serum possesses of inhibiting the action of trypsin on coagulated proteins, is increased in malignant disease. The observations are made by making mixtures of trypsin with varying amounts of the blood-serum of the patient, and observing the limit at which the mixture ceases to exert a digestive action on coagulated blood-serum. It is held by many workers that a marked increase in this antitryptic power is a valuable indication of the presence of a malignant growth, and still more that the absence of such an increase goes a long way towards excluding the presence of such a condition.

It has also been pointed out by Shaw-Mackenzie and Rosenheim⁴ that normal blood-serum contains a substance which accelerates the lipoclastic (fat-splitting) action of pancreatic extracts on neutral fats, and that this substance is usually markedly increased in carcinoma. These reactions have not yet, however, come into general use for diagnostic purposes, and the data at our disposal are not yet sufficiently numerous for us to form a satisfactory judgment on the reliability of the results obtained.

¹ Marcus, *Berl. klin. Wochenschr.*, 1908, vol. xlv. p. 689.

² Brieger and Trebbing, *Berl. klin. Wochenschr.*, 1908, vol. xlv. p. 1041.

³ Shaw-Mackenzie, *Proc. Roy. Soc. Med.*, London, Therap. and Pharm. Section, 1912, vol. v. p. 152.

⁴ Shaw-Mackenzie and Rosenheim, *Proc. Roy. Soc. Med.*, London, Path. Section, 1910, vol. iii. p. 168.

MALFORMATIONS OF THE FEMALE GENERATIVE ORGANS

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INTRODUCTION

MALFORMATIONS of the female generative organs differ from similar structural anomalies in other systems of the body in two respects. In the first place they are not exclusively congenital or pre-natal in origin, for the development of the genital organs in woman is not completed before birth; a part, not indeed a very important part, of organogenesis is left to be carried through after birth, and in its accomplishment errors of formation may occur which are post-natal in time; thus it comes to pass that there is a small group of genital deformities having their inception during the years which intervene between birth and puberty. In all other parts of the body (except the brain), and in all the other systems (with the exception of the nervous system), development is practically complete before birth, and therefore maldevelopments do not, cannot, arise after that event. In the second place malformations of the generative organs differ from structural deviations elsewhere in the postponement of the functional anomalies to which they give rise. During the first twelve or thirteen years of life these reproductive organs are almost wholly quiescent; they perform no functions when normally formed, and cannot therefore exhibit any divergencies of physiological activity when abnormally constituted. These two peculiarities which attach to genital malformations may be best appreciated by instances. As illustrating the first, one may bring forward the case of the *uterus foetalis*: at birth the body of the uterus is relatively small and the cervix is relatively large, but as childhood progresses the body grows more quickly than the cervix, and at puberty the former has become much larger than the latter, and this is its normal development; if, however, during the post-natal months and the pre-pubertal years the pre-natal

proportionate size of uterine body and cervix is maintained, a malformation (*uterus foetalis*) is produced by reason of defect in development. In illustration of the second peculiarity the imperforate condition of the lower part of the vagina may be cited: during infancy and childhood when the secretions of the uterus and vagina are little or nothing, the defective formation of the canal need give rise to no trouble, and may not be suspected to exist; but when the *menarché* is reached, and a menstrual discharge accumulates in the vagina, suffering is caused, and the vaginal atresia can no longer be overlooked.

Etiology and Pathogenesis of Malformations.—It is in disordered embryology that one must look for the explanation of the various deformities of the generative organs, and malformations of the reproductive organs have not seldom caused the embryologist to revise or scrutinize the mode of development of these parts commonly accepted and set forth in the text-books. It is a very remarkable, but not at all an inexplicable fact, that with each advance in knowledge of the mode of formation of the generative organs has come the clearer understanding of one or more of the malformations of these parts, and that as the clinical and pathological records of genital malformations have increased in number new light has almost invariably been thrown upon the difficult problems of organogenesis in the reproductive system. Teratology and embryology depend upon each other; the one helps to explain the other; the one without the other would be an indecipherable legend. Malformations are simply disorderly formation, and teratology is nothing more than the pathology of embryology. Very slight investigation of these two subjects is needed to show that genital deformities generally represent early stages in development which have failed to pass on into later and more mature phases. Thus, the simple fact that the single organ the uterus is formed by the union and fusion of the middle and lower parts of the two Müllerian ducts gives at once an explanation of most of the structural anomalies grouped under the heading of "double uterus." In this way it can be seen that the uterus with the flat fundus (*u. planifundalis*), or with a notched fundus (*u. cordiformis*), the *uterus septus* and *subseptus*, and the various degrees of the *uterus bicornis* are all of them instances of incomplete fusion of the Müllerian ducts; they represent conditions which have become permanent for the individual, but which ought in the normal process of development to have been quite transitory, and which are in general purely transient in the ante-natal life of the female embryo. All the malformations of the generative organs are not, however, explicable in so easy a fashion; but it is almost invariably found that when there is any doubt regarding the mode of origin of a deformity there is also much obscurity about the development of the organ which is malformed.

This is particularly true of the anomalies of the vulva and lower third of the vaginal canal.

The causes of these examples of arrested development of the reproductive organs, which are termed genital deformities, are in all probability the same as are active in producing malformations of other organs and in other parts of the body. Their discussion lies somewhat outside the sphere of the present work; but it may be said generally that, whilst in some of them the element of heredity may be traced, in others it is fair to invoke nutritional disturbances of the organism in its foetal, embryonic, or germinal stages of development.

It is necessary, in my opinion, to think of nutritional disturbances in any one or in all the periods of ante-natal life, as well as in the post-natal epochs of infancy and childhood, for, without some such supposition, the various types of arrested development cannot be completely accounted for. Further, the nutrition must be regarded as subject to disturbance arising from such different causes as toxic, toxicin, microbic, chemical, and physical agencies. Thus, to account for such fundamental anomalies as absence of the whole or the chief parts of the reproductive system, it will be necessary to look for some state of the health of the mother or father which has influenced the ova or spermatozoa before or just after their union to form the zygote or impregnated ovum. On the other hand the commoner malformations which exhibit, so clearly, delayed development, *e.g.* the uterus didelphys or bicornis, may be ascribed to defective nourishment of the embryo in the early months of the mother's pregnancy, in the weeks following conception, when the fusion of the Müllerian ducts into tubes, uterus, and vagina is in progress. Again, the slighter anomalies, as exemplified by defects in the rounding of the fundus uteri and in the state of the ovaries, may have been caused by disturbed nutrition in the foetal period of ante-natal life. Yet, again, the still less marked anomalies which arise in the reproductive system after birth, such as the presence of foetal or infantile characters in the uterus and its adnexa, may be attributed to defective supply of nourishment to the parts in the young child, due to faults in the diet and hygiene of the child herself, or to illnesses through which she has passed which have interfered with the healthy life of all her tissues, including, of course, the generative organs. Among the causes which lead to the nutritional defect, one should, I think, specially consider syphilis, which is so intensely inimical to ante-natal and to early post-natal vitality, long-continued and habitual alcoholism, destructive toxicological states, such as well-marked plumbism, the more prolonged and wasting exanthemata, such as typhoid fever, and the various local morbid conditions which directly limit the supply of blood to the growing organism, such as decidual hæmorrhages and

placental degenerations. It is, of necessity, difficult to obtain evidence, at any rate evidence of a direct and convincing kind, in support of these views. Artificial teratogenesis has already afforded some proof, whilst the closer scrutiny of family histories which a registration of ante-natal deaths and their causes will make possible, and which the unsuspected presence of syphilis so loudly calls for, and also the keener and better organized investigation of all specimens of ante-natal pathology, which is surely coming, will unite together in giving facts and data on which to found, or by which to test, the accuracy of the nutritional theory of origin of the malformations of the various parts of the body, including those of the genital sphere with which we are here specially concerned.

Symptomatology.—It is not always in purely gynaecological conditions that the clinical manifestations of malformations appear; some of them require the development of the new conditions of pregnancy and labour before they become evident and recognizable. Thus it may happen that a woman who goes through life without child-bearing may carry in her generative organs a malformation which never reveals itself and of whose existence she is unaware; the special circumstances of pregnancy are needed to bring the deformity to light. Similarly, but in a less degree, the woman who does not marry may suffer from an anomaly of the vagina or vulva which passes unsuspected; in wedlock, however, its presence would have become manifest. In other words the full performance of all the functions of the female generative organs is necessary to reveal the complete series of their defects: some of these, such as ovarian imperfections, make their existence felt at the *menarché*; others, such as the states known as pseudo-hermaphroditism, appear only in later adolescence and at the time of nubility; others, such as the vaginal atresias and vulvar constrictions, remain latent, so to say, till marriage has taken place and cohabitation has begun; others, such as tubal defects, exist unknown till pregnancy occurs; and yet others, such as the septate or bicornute uterus, require the special exigencies of a confinement to bring them into evidence. This work is, of course, a gynaecological one, but it will be necessary to refer to some at least of the obstetrical effects produced by malformations of the female reproductive organs; at the same time the emphasis will be consistently placed upon the symptoms and signs which belong peculiarly to gynaecology. In such a subject as sterility arising from structural anomalies, obstetrics and diseases of women may be said to meet on common ground; it belongs to both.

ANOMALIES OF THE OVARIES

The frequent opening of the abdomen in modern practice has given to the operator opportunities for discovering anomalous conditions of the ovaries during the life of the patient such as were not in the possession of the gynaecologists of thirty or forty years ago. The physiological importance of the ovary has also been increased by the discovery that it serves not solely as a nest for ovisacs but is active too as a gland with an internal secretion which is of great value in the general metabolism of the body. On the other hand it is true that within recent years evidence has been accumulating to show that the ovaries are not so predominantly the glands ruling over the sexual life of the woman as had been thought; there is some proof that others among the ductless glands or endocrinous organs are not without an influence upon the feminine characteristics of the individual, and even that (as Blair Bell¹ has stated it) femininity is dependent upon all the internal secretions.² These considerations increase the necessity for a more exact acquaintance with the anomalies of the ovaries than has as yet been possible.

Supernumerary and Accessory Ovaries.—If the term *supernumerary ovary* be restricted (as Seitz³ has advised) to ovaries which are independent of, but are of equal importance with the normal pair, then it must be admitted that such an occurrence is rare; and if it is insisted that the additional gland must have a Fallopian tube and an ovarian ligament associated with it, then the number of well-authenticated instances is reduced almost to vanishing point. Von-Winckel's case⁴ of a third ovary in front of the uterus and attached thereto by a strong ovarian ligament stands practically alone; but Seitz (*loc. cit.*) was able in 1900 to collect at least five cases of additional ovaries associated with extra Fallopian tubes. They may be found near the normal gland or at some distance away. R. T. Frank,⁵ for instance, after removing the uterus and the appendages on the right side, and also a cyst affecting the left ovary with its tube, discovered a cyst the size of a small walnut lying retroperitoneally over the right external iliac artery; this was found to be a papilliferous cyst (similar to that in the left ovary) adherent to a tube with a fimbriated extremity. Sippel's case⁶ of a papillomatous tumour in a third ovary in the right broad ligament can hardly be regarded as more than a tumour arising in a detached piece of ovarian tissue. Indeed the literature of this anomaly shows much confusion between true supernumerary ovaries and purely accessory lobes of ovarian tissue in various situations.

¹ *Lancet*, i. for 1913, p. 944.

² *Samml. klin. Vortr.*, n. F. 286, 1900.

³ *Surg. Gynec. and Obst.* viii. 1, 1909.

⁴ See also Article on Physiology (p. 91).—EDITORS.

⁵ *Lehrb. der Frauenkrankheiten*, p. 595, 1886.

⁶ *Monatsschr. f. Geburtsh. u. Gynäk.* xxxi. 379, 1910.

Many more instances are on record of the distinctly accessory pieces of ovarian tissue. The writer has, in conjunction with the late J. D. Williams, reported a case of this kind. The accessory gland was of the size of a large pea; it was made up of ovarian stroma with Graafian follicles, of which one at least had burst leaving a cicatrix; and it was attached to the anterior border of the right ovary by a stalk which consisted partly of fibrous tissue, with an external coating of low cubical epithelium, and partly of solid columns of epithelial cells enclosed in fibrous tissue. Mauclaire and Eisenberg-Paperin¹ were able in 1911 to collect some fifty cases from medical literature in which accessory ovaries were described, but they warn their readers that not in all these cases was microscopical proof of the ovarian nature of the swelling forthcoming. There is need for this reservation,



FIG. 104.—Case of *ovarium disjunctum*. (After Cavalé.)

for two other structures may easily be mistaken for accessory ovaries: one is the small fibromyoma of the ovarian ligament, the occasional occurrence of which was pointed out several years ago by Doran, and the other is the rare fibro-adenoma of the ovarian fimbria of the tube to which reference has been made by Glendinning.² A histological identification is essential. A favourite explanation of the origin of these accessory ovaries is foetal peritonitis leading to the division of the gland into two parts, and it is on this account that Frankl³ desires the adoption for them of the name "*ovarium disjunctum*." A very good example of this duplication of the ovary (*vide* Fig. 104) by some ante-natal cause (peritonitic band or other condition) has been furnished by Cavalé.⁴ The right ovary in the body of a young woman who had died of puerperal septicaemia was found to be divided into two by a narrow neck; the inner half was attached to the uterus by a short ovarian ligament, and the outer half adhered to the ovarian fimbria of the Fallopian tube; each part contained typical ovarian tissue, but the narrow connecting part was made up

¹ *Arch. gén. de chir.* vii. 755, 1911.

² *Journ. Obstet. and Gynaec. Brit. Empire*, xxi. 311, 1912.

³ *Zentralbl. f. Gynäk.* xxxvi. 604, 1912.

⁴ *Bibliogr. anatomique*, ix. 64, 1901.

chiefly of unstriped muscular tissue. Aberrant accessory ovaries are also met with in various situations along the line of the descent of the ovary before birth, and Meriel¹ regards these as likewise produced by foetal peritonitis very early in ante-natal life. Such aberrant ovaries have been found attached to the great omentum, the small intestine, the caecum, the colon, and the outer surface of the parietal peritoneum. It has, however, to be borne in mind, as Berry Hart² has pointed out, that all the stages in the descent of the ovaries have not yet been fully investigated. W. P. Manton³ found a small third ovary lying under the peritoneum behind the uterus in the tissue of the cervico-vaginal junction, and others have reported ovarian structures in the neighbourhood of the ureter.

Supernumerary and accessory ovaries have a clinical importance which is not to be underestimated. They are very often the seat of neoplastic changes; indeed the frequency with which tumours have been found developing in these aberrant structures is a very striking and significant phenomenon. One discovers in them the pathological explanation of the clinical fact that after both ovaries have been removed for cystic or dermoid growths a third tumour, showing also ovarian elements, may require operation; of course this third growth must be situated in a position excluding the possibility of its having arisen from ovarian tissue left in the pedicle of one or other of the tumours already taken away. These aberrant ovaries, too, supply the explanation of the cases, not so rare as was once thought, of pregnancy after the removal of both ovaries (Doran,⁴ Baldwin⁵ and others); and the occasional continuance of menstruation after double ovariectomy or oöphorectomy may be possibly likewise explained; at the same time one is warned by recent researches upon the other ductless glands, and especially upon the suprarenal bodies, not to lay too strong an emphasis upon this explanation, for evidence is accumulating of a correlation of function amongst these endocrinous organs which would at any rate help to explain the continuance of menstruation. It is possible, also, that accessory ovaries may explain why double oöphorectomy has sometimes failed to benefit the osteomalacia for which it was undertaken. It may be noted that the presence of supernumerary or accessory ovaries does not carry with it increased or even normal fertility, for in some of the reported instances the individual was sterile; this is not surprising, for if foetal peritonitis be the cause of the *ovarium disjunctum* the same disease may also have destroyed the ovisacs in the duplicated ovary.

¹ *Paris méd.*, pp. 419-423, 1910-11.

³ *Surg. Gynec. and Obstet.* ii. 29, 1906.

² *Trans. Edin. Obst. Soc.* xxxiv. 158, 1909.

⁴ *Journ. Obstet. and Gynaec. Brit. Empire*, ii. 1, 1902.

⁵ *Amer. Journ. Obstet.* xlv. 835, 1902.

Absence and Rudimentary State of Ovaries.—Complete absence of both ovaries, save in some excessively deformed fetuses of the sympodial and the acephalic type, is almost unknown in individuals otherwise furnished with feminine characteristics. It is difficult to determine what was the exact state of things in the patient operated on by J. Wilson Poucher;¹ she was a violently insane single woman of the age of sixty-five; her abdomen was found to contain a large calcareous fibroid; and the uterus, although provided with two Fallopian tubes, showed no traces of broad ligaments or of ovaries. Ovaries may have been present here but situated in an abnormal position. Cases, such as Egger's,² in which one ovary is absent are also rare, and in the few reported instances the ovarian defect has generally been associated with absence of the structures developed from one Müllerian duct (*i.e.* Fallopian tube, one horn of the uterus, and part of the upper portion of the vagina) and not uncommonly with absence of the corresponding kidney. Gottschalk³ has recorded a case of absence of one ovary and Fallopian tube in which the other gland had the form of a horse-shoe. Some doubt must continue to exist whether it is possible to have a normally developed uterus in a patient with absence of one ovary; in fact it is impossible to be certain regarding these anomalies unless a complete post-mortem examination has been made.

From the clinical standpoint a rudimentary development of one or both ovaries is equivalent to absence of these glands, for it makes them 'functionally absent.' The ovaries may retain their foetal or infantile characters, or they may resemble the condition in which the genital gland is found before the distinction between it and a testicle can be made with certainty. Their maldevelopment may be associated with a foetal, an infantile, or a bicornute uterus, with rudimentary tubes, with congenital stenosis of the aorta, and with hypoplasia of more distant organs; they may also be displaced.

If only one ovary be absent or rudimentary, there may be no marked effect produced upon the woman's reproductive powers; but when both glands are defective or ill-developed, the pubertal changes (menstruation, appearance of hair on the mons veneris and elsewhere, widening of pelvis, etc.) may take place incompletely, and the individual may approximate to the male rather than to the female type, or may remain child-like, with or without some mental weakness. Chlorosis, too, would appear to have some relation to imperfect development of the ovaries. Of course if the ovaries are absent, or if they contain no ovisacs, or if the ovisacs enclose defective ova, there must be sterility in adult life. But these glands have a second

¹ *Trans. Amer. Assoc. Obst. and Gynec.* xxv. 313, 1913.

² *Dissertation*, München, 1901.

³ *Zeitschr. f. Geburtsh. u. Gynäk.* xlix. 112, 1903.

function, the providing of an internal secretion or secretions, and it seems reasonable to expect that the non-provision of this secretion will be followed by a defect in the development of the secondary sexual characteristics which are usually ascribed to its action. It is not, however, by any means certain that this is so, for experimental work rather points to the ovarian secretion as one of several which act together for obtaining and maintaining the secondary sexual characters of a woman. Russell Andrews' case (unpublished as yet), of an individual eighteen years of age who possessed every female characteristic and yet had neither uterus, Fallopian tubes, nor ovaries, but had undoubted testicles in the abdominal cavity, is a most puzzling and apparently paradoxical one. This pseudo-hermaphrodite¹ had well-developed breasts, a vaginal cul-de-sac two and a half inches deep, a normal vulva without pubic hair, and there had been slight bleeding from the vagina. All that can at present safely be said is that the other ductless glands have to do with sexual characters to a much greater extent than was formerly thought possible. There is one caution, however, which must be observed, namely, that removal of organs in adult life will not necessarily be followed by the same changes as those which are produced by ante-natal absence of these structures.

It is almost impossible by symptomatology and physical examination to determine the exact state of the development of the ovaries, and even opening the abdomen will not always accurately reveal the true state of matters. In respect of the treatment of rudimentary ovaries there is a tendency to ban such means as stem pessaries, electricity, and the like, and to try rather the effect of one or other of the organic extracts, including, of course, ovarian extract itself, the thyroid, and the pituitary; but it is well to remember that such therapeutic endeavours are mostly empiric.

Displacements.—Two displacements of the ovaries are met with, *non-descent* and *excessive descent* into an inguinal canal. The former must be regarded as an incomplete *descensus*, but unfortunately for its proper understanding all the normal stages are not known. The ovaries lie at first on the inner and anterior aspects of the Wolffian bodies in the lumbar region; about the fifth or sixth week they are lower down and lie behind the genital cord; and later still they are found on the brim of the pelvis in their adult position opposite the sacro-iliac synchondroses. Berry Hart² thinks that normally they descend no farther because of the arrested development of the round ligament (as compared with that of the gubernaculum in the male). Bland-Sutton has found the right ovary adherent to the lower border of the kidney, and I have met with a case in a new-born infant in which it was

¹ The case is further referred to in Article on Disorders of Function (p. 308).—EDITORS.

² *Trans. Edin. Obstet. Soc.* xxxiv. 157, 1909.

attached to the caecum. As has been noted already, an accessory ovary may occupy an unusually high position, and, further, non-descent is apt to be associated with duplication of the uterus due to deficient union of the Müllerian ducts; the displaced ovary, too, is prone to neoplastic changes, sometimes of a malignant nature. Excessive descent of the ovary into the inguinal canal, and even as low as the labium, is equivalent to the normal condition for the testicles, just as non-descent of the testicle (*ectopia testis*) is equivalent to the normal state for the ovary; but to the former the name of *hernia of the ovary* is commonly given. It may sometimes occur as a congenital condition although the acquired form is much more common, and doubtless it is predisposed to by an abnormal relationship of the round ligament to the inguinal canal and labium. Cases in young infants have been reported by Charon,¹ May,² Muniagurria,³ Nicoll,⁴ and Pollard.⁵ The displaced ovary is often accompanied by the Fallopian tube, and in Nicoll's patient the two structures were in the labium, became strangulated by torsion of the pedicle, and so simulated a strangulated inguinal hernia. If a rounded or oval body be found in the inguinal canal or labium, if the normal ovary is absent from its usual position as determined by a careful bi-manual examination, and if it (the rounded body) become larger and more painful at monthly intervals, it will generally be wise to cut down upon it. It may turn out to be a descending testicle in a male who has some of the external appearances of a female, and so the operation may help to clear up the question of the sex of the individual; it may, on the other hand, be an ovary, when the operation will prevent the risk of strangulation; and in either case it will be better to remove it, for such displaced glands are liable to undergo cystic and possibly malignant changes. It is rarely wise to try to reduce the ovary, and the wearing of a cup-shaped shield over it is inadvisable. It need not necessarily be removed if it appear to be healthy, but may be returned to the opened abdomen and even affixed to the broad ligament of the same side. (See also Article on Hernia, Vol. III. p. 222.)

ANOMALIES OF THE FALLOPIAN TUBES

Like the anomalies of the ovaries those of the tubes may be classified as abnormalities by excess, by defect, and by altered relationship. Less is known about them than about ovarian deformities, but they may be no less important, especially in connection with ectopic gestation.

¹ *Journ. de clin. et de therap. infant.* vi. 21, 1898.

² *Brit. Med. Journ.* i. for 1891, p. 1389.

³ *Semana med.* (Buenos Aires), ix. 396, 1902.

⁴ *Glasgow Med. Journ.* lviii. 40, 1902.

⁵ *Lancet*, ii. for 1889, p. 165.

Supernumerary Fallopian Tubes and Accessory Ostia.—The true supernumerary tube, like the true third ovary, is an exceedingly rare anomaly; even Bab's cases¹ are in all probability not genuine instances. Indeed F. Kermauner² goes so far as to say that a clearly proven case of complete duplication has not yet been shown to exist. Accessory tubal ostia, on the other hand, are far from rare. J. D. Williams and the present writer³ observed two cases in sixty-one consecutive post-mortem examinations, and this agrees fairly closely with Kossmann's estimate⁴ of from 4 to 10 per cent. Commonly there is only one accessory ostium (*vide* Fig. 105) in a

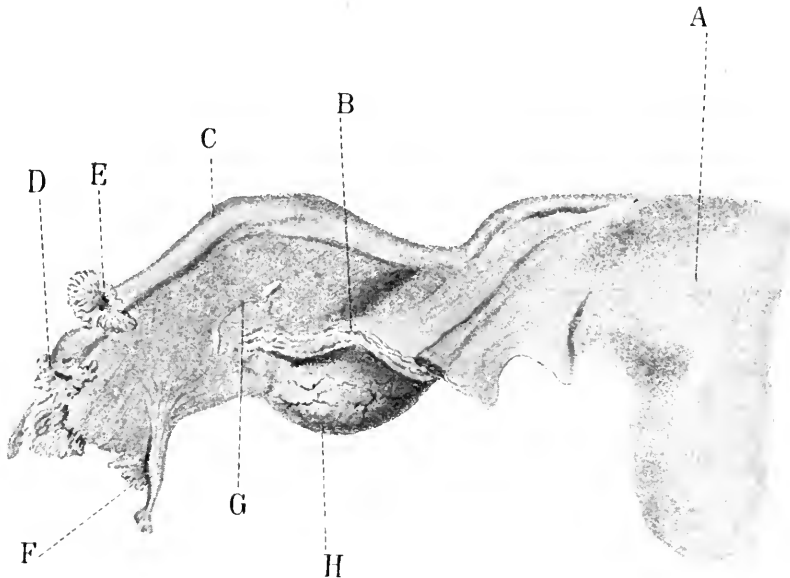


FIG. 105.—Anterior view of right uterine appendages, showing accessory abdominal ostium of tube.

A, Uterus; B, cut surface of mesovarium; C, right Fallopian tube; D, fimbriated extremity; E, accessory ostium abdominale; F, free fold of anterior layer of mesosalpinx; G, pedunculated cyst; H, right ovary.

given case, but two, three, four, and even six ostia have been met with (Ferraresi⁵). The ostia are either sessile or pedunculated, and they are usually surrounded by fimbriae; they lie generally on the upper convex border of the tube, near its outer end (*ostium abdominale*), and sometimes they communicate with the tubal lumen. Their origin has been ascribed to supernumerary embryonic relics of Müller's duct lying parallel to the primary Müllerian duct, but, lately, with more probability, to faults in the secondary dehiscence of the Müllerian duct (Handley⁶). It is more

¹ *Arch. f. Gynäk.* lxxviii. 393, 1906.

² In Schwalbe's *Morphologie der Missbildungen*, III. ii. pt. 2, p. 311, 1909.

³ *Brit. Med. Journ.* i. for 1891, pp. 107, 168.

⁴ *Ztschr. f. Geburtsh. u. Gynäk.* xxix. 253, 1894.

⁵ *Ann. di ostet.* xvi. 521, 1894.

⁶ *Journ. Obst. and Gyn. Brit. Empire*, iv. 458, 1903.

than likely that many broad ligament cysts, formerly regarded as parovarian, really

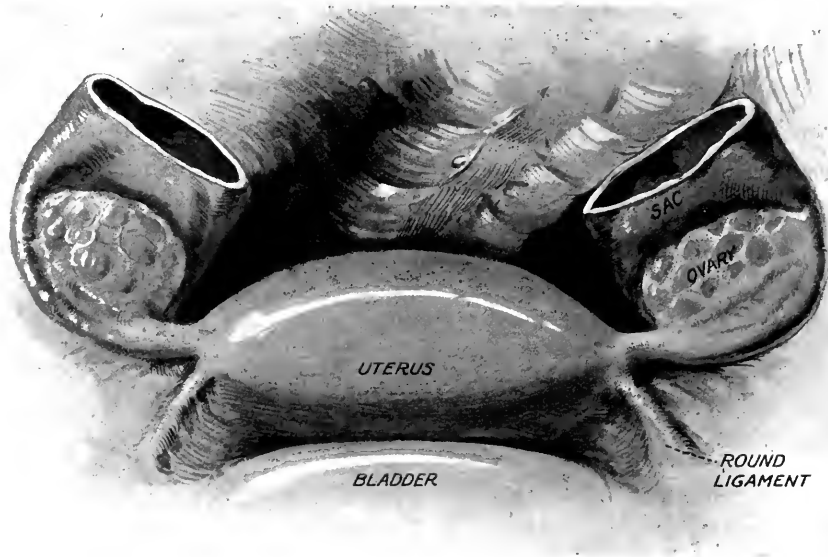


FIG. 106.—Spencer's operation. (After Chill.) (*Medical Press and Circular*, May 31, 1911.)
First Stage.

arise in accessory tubes and constitute cases of hydrosalpinx of these accessory tubes. Macnaughton-Jones¹ has found histological evidence in support of the

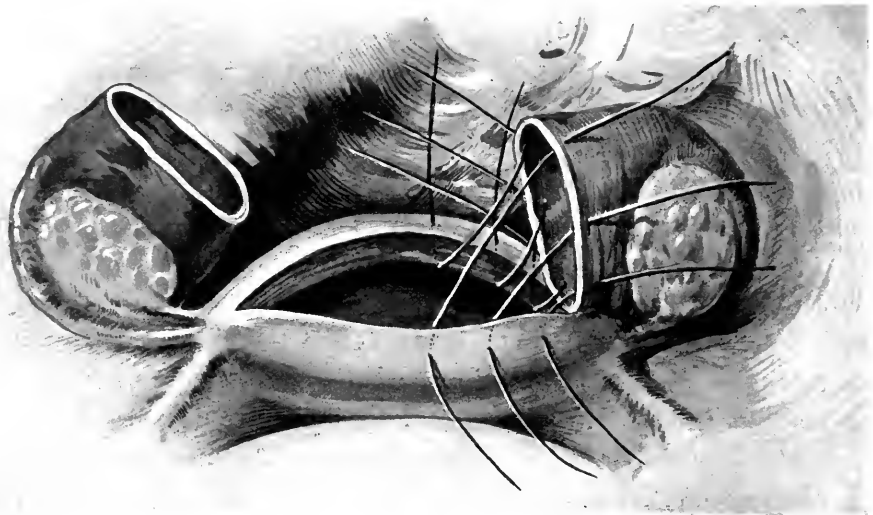


FIG. 107.—Spencer's operation.—Second Stage.

above-named view. If these additional ostia are to be looked upon as due to lack in the dehiscence of the Müllerian duct, then the somewhat curious and paradoxical

¹ *Journ. Obst. and Gyn. Brit. Empire*, vi. 212, 1904.

result follows that they ought to be grouped with the anomalies of defect instead of with those of excess. Ferraresi (*loc. cit.*) has given the name tubal appendages

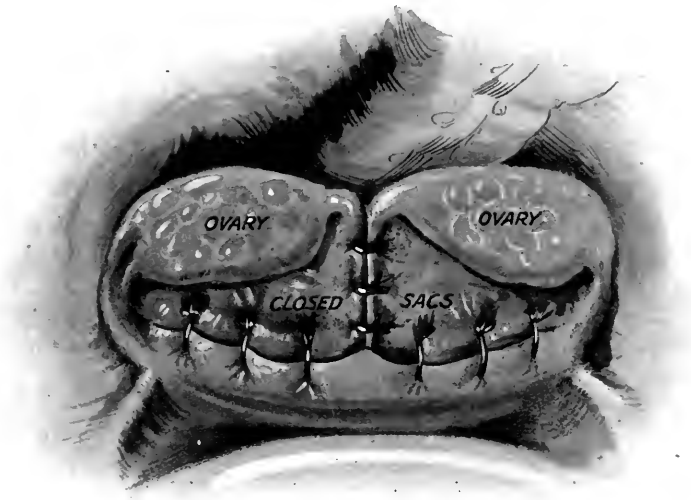


FIG. 108.—Spencer's operation.—Third Stage.

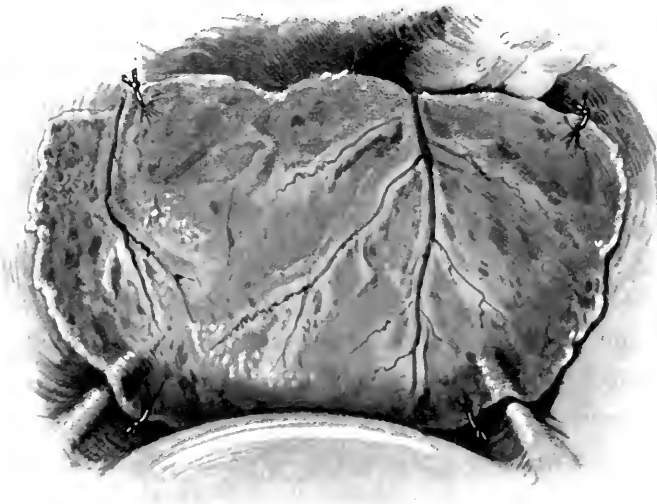


FIG. 109.—Spencer's operation.—Fourth Stage.

(*appendici tubae*) to little tufts of fimbriae with solid stalks and no ostia ; they have probably the same origin as the accessory ostia.

From the clinical standpoint accessory tubal ostia can hardly be expected

to be recognized by the gynaecologist apart from the opening of the abdomen. That they may become the seat of cystic changes has already been mentioned. Whether they are to be regarded as one of the causes of ectopic pregnancy must remain an open question; but it has to be borne in mind that some claim to have described specimens of pregnancy in accessory tubes, and Walthard¹ found a young ovum in the little mesosalpinx of an accessory tube. The exact meaning of the diverticula which are sometimes found in the Fallopian tube is not settled; they also may have some etiological connection with tubal pregnancy.

Absence and Rudimentary State of the Fallopian Tubes.—Absence of both tubes is very rare, and when it does occur it is usually combined with absence of the uterus, but a few cases have been reported in which the uterus was present and even normal. W. G. Spencer² reported such a case in 1910. The patient, an unmarried woman of twenty-eight years, suffered from recurrent monthly attacks of peritonitis, and had never menstruated. As her suffering was preventing her from earning her living, Spencer decided to open the abdomen. The omentum was found adherent to the fundus uteri, and when it was separated the appendix (which had been suspected) was found to be normal; the uterine body was normal, but at each corner there was a pea-like knob, one of which contained a small dermoid cyst and the other was fibrous; there were no traces of Fallopian tubes, and the ovaries lay in small pouches formed by peritoneal adhesions (Fig. 106). Spencer split open the fundus uteri (Fig. 107), stitched the orifices of the two ovarian pouches so as to establish a continuity with the uterine cavity, and over them he fastened an omental graft (Figs. 108 and 109). The patient after the operation ceased to suffer from the periodical peritonitic attacks. Somewhat curiously Spencer had an opportunity of operating upon a similar case soon afterwards. The patient had been married three years, had never menstruated, and had had monthly attacks of recurrent peritonitis. She was under the care of E. A. Chill. The conditions found on opening the abdomen were not quite the same: on each side there was a small conical stump representing the Fallopian tube, and the ovaries were lying adherent in the pouch of Douglas. A slightly modified procedure was followed, the fundus uteri being split open, the ovaries separated from their adhesions and fixed to the uterine incision, and an omental graft placed over all. There was in this case also no return of the peritonitic attacks. Chill³ suggests the name "Spencer's operation" for the procedure followed, and the term is quite appropriate.

¹ *Ztschr. f. Geburtsh. u. Gynäk.* lxi. 553, 1911.

² *Brit. Med. Journ.* ii. for 1910, p. 926; i. for 1911, p. 189.

³ *Med. Press and Circ.* n.s., xci. p. 566, 1911.

Absence of one tube is less rare, and it is generally associated with the *uterus unicornis* and with absence or defective development of the corresponding ovary; sometimes the kidney of the same side is also lacking. Occasionally, as in Colomiatti's case,¹ the uterus is well formed. Absence of both tubes, of course, entails sterility, but pregnancy has occurred, as in Chavannaz's patient² in whom the tube and ovary of one side were lacking. As Spencer's observations have shown, the characteristic symptom of absence of tubes with presence of ovaries is recurrent peritonitis, due probably to rupture of Graafian follicles and the discharge of ova into the abdominal cavity.

Rudimentary development of the tubes may take different forms. Thus J. D. Williams and the present writer³ recorded a case in which there was congenital

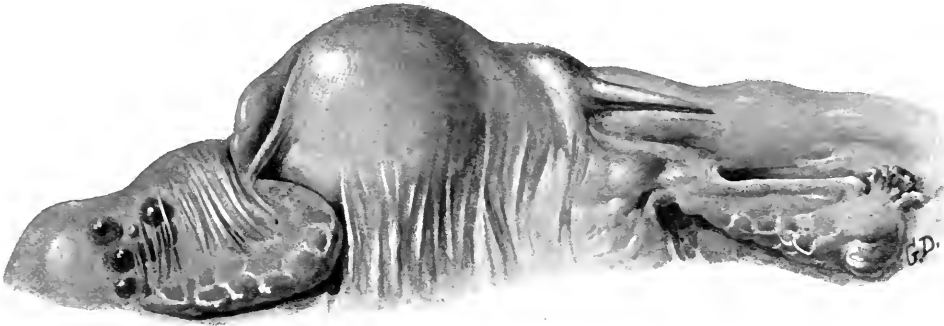


FIG. 110.—Absence of outer two-thirds of right oviduct. (Ballantyne and Williams.)

absence of the outer two-thirds of the right oviduct, the inner third having a lumen and tapering to a point (*vide* Fig. 110); the ovaries were present; and the patient had suffered from genital tuberculosis. In Croft's patient,⁴ who suffered from dysmenorrhoea and dyspareunia, each tube was reduced to a rudiment about half-an-inch long attached to a uterine cornu, and the uterus itself was small and cylindrical; the ovaries were present but had no mesovaria.

In two specimens shown by Cuthbert Lockyer in 1906⁵ there was absence of the portion of the Fallopian tube lying internal to the fimbriated extremity, between it and the uterine cornu of the same side (Fig. 111). In one of the patients from whom the specimens came there was a history of epileptic seizures, and it was on account of the nervous malady that oöphorectomy was performed and the tubal anomaly thus brought to light. The uterus in this case was poorly

¹ *Frammenti di embriologia patologica*, p. 14, 1880.

² *Journ. de méd. de Bordeaux*, xxvi. 361, 1896.

³ *Structures in the Mesosalpinx*, p. 25, 1893.

⁴ *Journ. Obstet. and Gynaec. Brit. Emp.* xxi. 360, 1912.

⁵ *Trans. Obst. Soc. Lond.* xlviii. 75-82, 1907.

represented by two small cornua, and the ovaries showed a sign of arrested development, viz. the multiplicity of *primordial follicles* seen on section. In the other patient

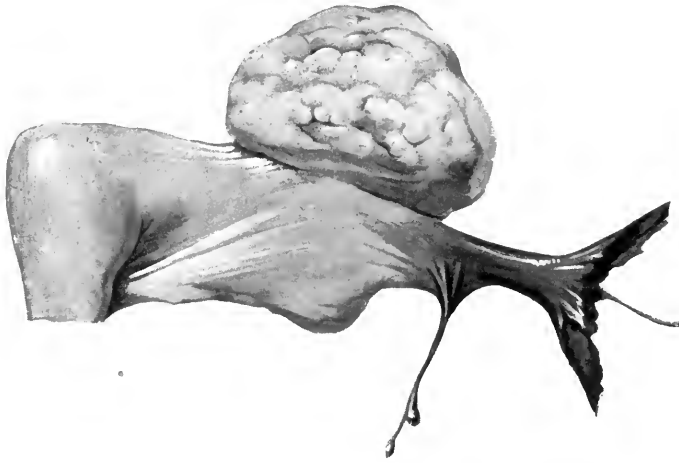


FIG. 111.—Non-development of the uterine cornu and of the Fallopian tube, except the infundibulum. (Cuthbert Lockyer.)

the tubal malformation was accompanied by a uterus bicornis. If the whole Fallopian tube is derived from the upper part of the Müllerian duct it is somewhat strange that the part of it lying between its outer end and the cornu of the uterus (also a Müllerian derivative) should be absent. As I suggested at the time in connection with Lockyer's specimens,¹ such an occurrence may point to a different origin for the outer end of the Fallopian tube; the tubal infundibula may, in other words, show some independence of the Müllerian system.

Sometimes the rudimentary development of the tube takes the form of absence of the normal tunnelling, and the structure remains a solid cord of fibrous or muscular tissue; in other cases the outer end alone is imperforate, and may be devoid of fimbriae. In yet other cases, as has been pointed out by Höhne,² the defective formation consists in the absence of the cilia from parts of the mucous membrane, a sort of tubal hypoplasia, which Höhne thinks may have some effect in producing ectopic pregnancy. The persistence of the spiral convolutions of the tubes, which are characteristic of foetal life but which ought to disappear before birth, may perhaps be regarded as another sign of rudimentary development, and may also have some etiological bearing upon tubal gestation. Other clinical consequences of defective formation of the tubes are amenorrhoea, dysmenorrhoea, sterility (when the defect is bilateral), and recurrent peritonitis (when the ovaries are present). As with other malformations the explanation of the cause of tubal defects is to be sought in arrest of development in the embryonic stage. Some matters are still obscure, but did we know exactly the parts played by the pronephros and the Müllerian duct in the formation of the tube, we should be able to elucidate all the anomalies which are met with.

¹ *Loc. cit.*, *supra*, p. 79.

² *Ztschr. f. Geburtsh. u. Gynäk.* lxxiii. 106, 1908.

Displacement of the Fallopian Tubes.—Since the tubes are movable structures in the pelvis it is not surprising that even before birth they may become displaced, and I have seen instances of this in foetuses which had been the subjects of ante-natal peritonitis. A curious case, although not one of clearly established congenital origin, was reported by C. Hüter¹ in 1865; the tubes were displaced backwards and united at their abdominal ostia so as to form a ring behind the uterus. Forward displacement, too, has been recorded; thus, P. Wiart² met with a six months' child in whom the left tube was engaged in the abdominal opening of the inguinal canal, with the ovary lying near it. Bonnaire and Durante's observation,³ however, is of a quite peculiar kind: the specimen (*vide* Fig. 112) was obtained from the body of a woman who died of heart disease soon after her confinement; the right kidney was absent and the left was very large; the uterus was retroflexed and was normal in form; on the left side there was a normal broad ligament, tube, and ovary, but on the right side the margin of the uterus had no structures attached to it; in the right lumbar region, however, there was a Fallopian tube, with fimbriated end, an ovary with scattered ovisacs in it, and from the lower end of the tube a cord passed downwards to terminate at the internal inguinal ring. Bonnaire and Durante explain the origin of the displacement by the supposition that there was an arrest of development of the lower end of the right Müllerian duct; the upper part which had formed remained in its original lumbar position along with the corresponding ovary, perhaps because of the absence of the kidney.

Hernia of the Fallopian tube is not so common as hernia of the ovary. Frank T. Andrews⁴ has gathered together from literature 167 cases of hernia of the ovary without the tube, 80 in which both tube and ovary were herniated, and 46 of hernia of the tube without the ovary; of course many of these were not congenital cases. Of the 46 cases in which the tube alone occupied the hernial sac, 27 were inguinal, 14 were femoral, 2 were obturator, and 3 were unascertained. Among the congenital cases, G. T. Walther's observation⁵ was an interesting one: the child was six months old, there was a hernia of the left tube alone, and the corresponding ovary was found on the right side in the iliac fossa. Sometimes, as in Augier's patient,⁶ the tubal hernia becomes strangulated; but at other times the symptoms are to be explained by the occurrence of torsion of the tube. Damianos⁷ in 1905 and

¹ *Monats. f. Geburtsh.* xxv. 424, 1865.

² *Bull. Soc. anat. de Paris*, 6th s. i. 59, 1899.

³ *Bull. et mém. Soc. anat. de Paris*, 6th s. xiv. 128, 1912.

⁴ *Journ. Amer. Med. Assoc.* xlv. 1625, 1905.

⁵ *Ann. de gynec.* liii. 202, 1900.

⁶ *Rev. mens. de gynec. d'obst. et de pédiat.* iii. 456, 1908.

⁷ *Deutsche Ztschr. f. Chir.* lxxxv. 228, 1905.

Auvray¹ in 1912 have written fully on torsion of the tube in hernias, and the latter collected 19 cases from medical literature. The symptomatology of tubal torsion is somewhat similar to that of strangulation, but usually is of less severity, and the treatment consists in the opening of the sac and the removal of the tube, and of the



FIG. 112.—Case of absence of right broad ligament, with Fallopian tube and ovary in the right lumbar region. (After Bonnaire and Durante.)

ovary also if it accompany the tube into the hernia. Whether there are signs of torsion or not, it is wise to operate, and for the same reasons as in hernia of the ovary: it is not safe to leave the organ in its abnormal situation lest strangulation

¹ *Arch. mens. d'obstét. et de gynéc.* Ann. I. pt. 1, July 1912.

or torsion occur; pathological changes are liable to attack the displaced structure; and it may be necessary to clear up its true nature, as in cases of doubtful sex. (See also Article on Hernia, Vol. III. p. 224.)

Malformations of the Broad and Round Ligaments.—Closely associated with anomalies of the adnexa are the malformations and displacements of the folds of peritoneum which support them; but comparatively little has been clearly discovered regarding the normal and pathological development of the ligamenta lata and rotunda. Such a specimen as that described by Bonnaire and Durante (*vide supra*) shows that the broad ligament of one side may be entirely absent and yet the uterus retain its normal form; but, as a rule, this unilateral defect is accompanied by a uterus unicornis. Schottländer has demonstrated a case of bifurcation of the round ligament in the human subject, and Frankl has reported a similar arrangement in an ape.¹

ANOMALIES OF FORMATION OF THE UTERUS

By reason of the fact that the details of the development of the uterus from the Müllerian ducts are better known than the embryogenesis of other parts, and thanks to the investigations of Nagel,² von Winckel,³ and many others, it is possible to have a more complete and intelligent understanding of the malformations of this organ than of those of the Fallopian tubes and of the lower end of the vagina. Nagel, for instance, was able to group all uterine anomalies of formation into four sets: (1) there were those which appeared before the origin of the genital cord, including absence of the vagina and uterus, and the presence of two completely separate uteri and vaginæ; (2) there were those arising after formation of the genital cord, including the *uterus duplex bicornis cum vagina septa*, the *u. septus duplex (bilocularis)*, the *u. subseptus uniforis*, the *u. biforis supra simplex*, and the *u. subseptus unicorporeus*; (3) there were those arising whilst the fusion of the Müllerian ducts up to the origin of the round ligament was going on, including the *uterus bicornis unicollis*, the *u. arcuatus*, and the *u. subseptus unicollis*; (4) and there were those arising after the complete construction of the uterus and vagina, including the *uterus foetalis* and the *uterus infantilis*. F. von Winckel's scheme is more intricate, and at the same time more complete. He divided the life of the woman prior to sexual maturity into seven periods and allocated to each the malformations of the uterus which he regarded as developing in it. He began with the first month of ante-natal life in which the Müllerian ducts are formed in the germinal epithelium as solid cords

¹ *Zentralbl. f. Gynäk.* xxxiii. 997, 1909.

² Veit's *Handbuch der Gynäkologie*, i. 521, 1897.

³ *Über die Einteilung, Entstehung, und Benennung der Bildungshemmungen der weiblichen Sexualorganen*, 1899.

with hollow fimbriated ends. Peculiar to this period are the anomalies in which both the ducts (the uterus, the tubes, and the vagina) are entirely wanting, and the less uncommon cases in which one duct is wholly absent (*uterus unicornis sine ullo rudimento cornu alterius*). The second period was that of the second month of ante-natal life; in it the Müllerian ducts are hollow and have united in part of their extent (future uterus and vagina) into the genital cord. Four uterine malformations are characteristic of this stage: complete separation of the two ducts (*uterus duplex separatus, vagina duplex separata*); absence of canalization of the separated or united ducts (*uterus rudimentarius (duplex, bicornis, simplex), vagina solida*); partial canalization of the separated or fused ducts (*uterus rudimentarius partim excavatus (duplex, bicornis, simplex)*); and absence of one Müllerian duct with the presence of the other in an imperfect state (*uterus unicornis cum rudimento cornu alterius*). The third and fourth developmental periods passed from the third to the fifth ante-natal months, and during them the external fusion of the Müllerian ducts extended to the origin of the round ligaments and the septum within disappeared gradually (between the 13th and 16th weeks). The malformations peculiar to these stages of formation were four in number: the *uterus bicornis (septus, subseptus, simplex)* with *vagina septa, subseptata, simplex*; the *uterus introrsum arcuatus septus, subseptus, simplex*, with *vagina septa, subseptata, or simplex*; the *uterus planifundalis septus, subseptus, simplex*, with *vagina septa, subseptata, simplex*; and the *uterus foras arcuatus septus, subseptus, simplex*, with *vagina septa, subseptata, simplex*. Further, all these types might be united in various combinations to the number of thirty-six. The fifth developmental stage corresponded to the time from the sixth to the tenth (lunar) month of ante-natal life, and was noteworthy for the more marked development of the fundus uteri; one malformation was peculiar to it, the *uterus foetalis*. The sixth period was the post-natal one of the first ten years of life, during which the uterus was slowly losing its infantile characters; its peculiar anomaly was the *uterus infantilis*. The seventh period extended from the tenth to the sixteenth year and was characterised by the passage from the state of the virgin uterus to that of the fully-formed mature organ; its special malformations were three—the *uterus virgineus*, the *uterus inaequalis (s. obliquus)*, and the *uterus membranaceus (or hypoplasia uteri)*. It is to be noted that F. von Winckel's arrangement is not merely a convenient classification founded on embryology and organogenesis; it contains also a probable explanation of the causation of the anomalies, founded on the theory of arrested development. What is normal in one stage is abnormal in the next or in any later phase. To take a simple example: it is normal for the Müllerian ducts to be solid and separate in the first one of von Winckel's

periods ; but their complete separation, or their imperfect canalization are abnormal in the second stage and then constitute malformations. The first-stage normal, if arrested or fixed, becomes the second-stage abnormal or malformation. In this way a serviceable hypothesis of teratogenesis is afforded to the gynaeccologist, although one or two minor difficulties of formation are not quite explicable by it and one or two particular uterine anomalies (*e.g.* the *uterus accessorius*) are left mysterious. For the sake of simplicity the entire scheme as set forth by von Winckel will not be followed here in all its ramifications ; it will be sufficient to deal with malformations due to excessive, or to apparently excessive, formation, with those due to defect, and with those caused by altered relationship.

Uterus Accessorius and Trifid Uterus.—Under this heading are not included the double uterus commonly so called, for it is really nothing more than the two ununited halves of a single uterus ; but there are placed here a few rare cases in which there is something more than a mere lack of union of two halves of a symmetrical organ. To understand these most exceptional occurrences (*uterus accessorius* and *trifid uterus*) it must be borne in mind that in such double monsters as the thoracopagous or pygopagous twins each of the two united individuals may possess a uterus and a pair of ovaries and tubes ; in each of them the uterus is the result of the fusion of the two Müllerian ducts of that individual ; consequently, in theory at any rate, each might have a uterus in which fusion had failed in whole or in part, each might have an apparently double uterus. If now the united twins show a greater degree of fusion of parts, as in the cases of two heads, two bodies, and but one pelvis with three legs attached to it, then there may be two completely separate uteri each with a pair of tubes and ovaries, or there may be various degrees of fusion, *e.g.* two uteri with three ovaries, or two uteri with defective contiguous horns, etc. Further, the fusion of the two individuals may be still more complete and hardly any external indication of duplication be left ; but, just as there have been cases reported of double penis in the male and of double vulva in the female (*e.g.* Gemmell and Paterson's case, *vide infra*), so there may be instances of true duplication of the uterus in an individual otherwise single in every respect. Such a case would stand at the very opposite end of the chain of forms stretching from the completely double but united individuals known as the sternopagous or thoracopagous twins to this in which the only indication of doubleness is found in the uterus, and possibly also in the adnexa and vagina. If it were not for the existence of intermediate forms one might well be sceptical regarding the possibility of the existence of twins so fused that the only sign of duplication to be detected is the presence of two sets of Müllerian ducts represented by two uteri and vaginae ; if one

has, however, to abandon the hypothesis as untenable, then the only other supposition would seem to be the presence of a diverticulum from the fused part of the Müllerian ducts.

As has been said, instances of true accessory uterus are very rare. There was Skene's case¹ of a small second uterus lying in front of the normal one, and there was Holländer's somewhat similar case,² in which, however, the normal organ was retroflexed. In the latter instance the normal uterus had tubes, ovaries, and round ligaments attached to it, whilst the accessory one had neither adnexa nor round ligaments; there was a single cervix with two orifices, each communicating with one of the two uterine cavities. Perhaps here should be named the accessory uterus in the right broad ligament described by James Oliver in 1912.³ There was a uterus in the usual position with normal ovaries, Fallopian tubes, and round ligaments; the accessory one lay to the right side, was globular in shape, about two inches in diameter, contained menstrual blood, and showed under the microscope the typical appearances of the uterus (unstriated muscle, tubular glands, ciliated epithelium, etc.). The trifid uterus is still rarer; but Depage's case⁴ supplies an instance. There was in the first place a bicornute uterus with a single cervix and two internal cervical orifices, and there was, in the second place, a third uterine lobe forming a closed sac attached to the cervix and containing altered blood. Such a case is an instance of the combination in one patient of the two forms of uterine duplication, an apparently double (but really ununited) uterus, and a true but incomplete duplication of the organ.

No system of symptomatology can be constructed for these cases of accessory uterus, for their number is too small to supply sufficient clinical details. Two out of the four were discovered accidentally during a laparotomy, and another was diagnosed as an ovary fixed by adhesions and operated upon as such. As a general rule the malformation will run the risk of being mistaken for a fibroid tumour of the uterus, and it is difficult to see how an accurate diagnosis can be made without opening the abdomen; but the presence of two cervical orifices should excite suspicions. Holländer's patient had had seven labours, and had thrice aborted (once with twins); the placental tissue was found lying in the uterus accessorius, that is to say in the organ without adnexa; Oliver's patient had had two children and suffered from dysmenorrhoea; Skene's patient was troubled with leucorrhoea from the accessory organ; and Depage's patient was an unmarried girl. If, as is most likely, the abdomen has been opened as the result of a wrong

¹ *Treatise on the Diseases of Women*, p. 29, 1892.

² *Berlin. klin. Wochenschr.* xxxi. 452, 1894.

³ *Lancet*, i. for 1912, p. 1609.

⁴ *Arch. de toxocol.* xxi. 550, 1894.

diagnosis, it will probably be well to remove the accessory organ, for pregnancy, if it occur, will almost certainly end in miscarriage, and there seems also to be a tendency for blood to collect in the cavity and give rise to trouble.

Uterus Didelphys.—The *uterus didelphys*, or *diductus*, *duplex*, or *separatus* (for all these names have been given to it), has its two component halves so completely separate that each seems as if it were a single organ (Fig. 113). That each of them, however, is not a whole but a half is shown by the possession of only one ovary, tube, and round ligament. The vagina also may be either completely or incompletely double (*septa*, *subsepta*), or it may be single (*simplex*). G. Scott Macgregor¹ has collected a hundred cases of double uterus (including, however, the *uterus bicornis* as well as the *u. didelphys*), and his list is useful in showing how commonly pathological consequences are associated with the malformation. On

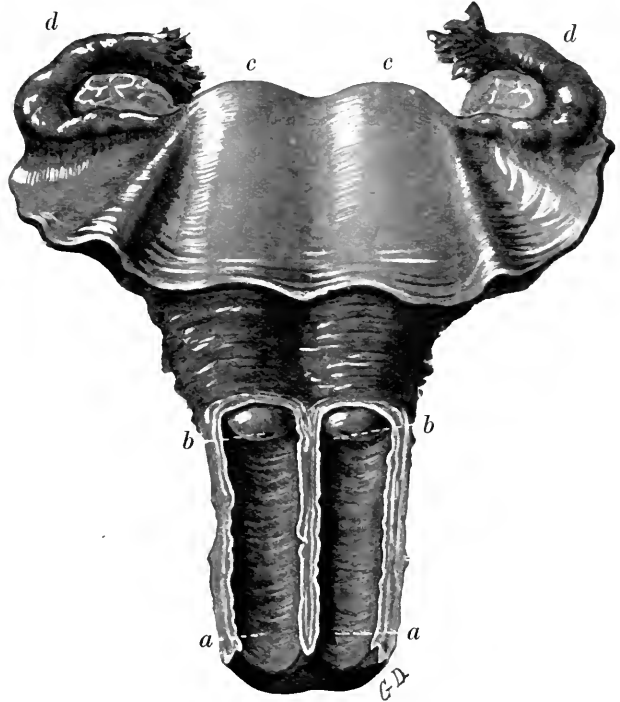


FIG. 113.—Uterus didelphys.

a, Vagina; b, portio vaginalis; c, fundus uteri; d, tube and ovary.

account of a lack of canalization of one or both uteri (*e.g.* atresia of cervix) haematometra and sometimes haematosalpinx result, and, since the double vagina may likewise be imperforate, haematocolpos and pyocolpos may follow. One or both organs may have foetal characters and one or both may be displaced; and Blair Bell has recorded an extraordinary case² in which each uterus or semi-uterus (to be more exact) lay in an inguinal hernial sac. One or both semi-uteri may contain a myoma, as in Ranken Lyle's³ and Violet and Cotte's⁴ cases; in the former Caesarean section was called for, and in the latter the myoma was discovered and enucleated during an operation for pyosalpinx and anal fistula. It is common to find a peritoneal fold, the vesico-rectal ligament passing between the two semi-

¹ *Journ. Obstet. and Gynaec. Brit. Empire*, ix. 336, 1906.

³ *Ibid.* vi. 438, 1904.

² *Ibid.* xvi. 136, 1909.

⁴ *Lyon méd.* cxviii. 1183, 1907.

uteri; and this structure has been regarded as allantoidal in origin, as caused by foetal peritonitis, or as a relic of the terminal intestinal mesentery. Some pathologists have looked upon it as the *cause* of the lack of fusion of the Müllerian ducts, whilst others (*e.g.* Nagel) have esteemed it a *result*. The early age in ante-natal life at which the uterus didelphys must arise seems to the writer to exclude the theory of peritonitis or any other disease, and to suggest the persistence of some structure (*e.g.* terminal mesentery) which normally disappears in time to allow the two Müllerian ducts to fuse. Another theory is that the Müllerian ducts are held



FIG. 114.—Uterus bicornis with a single os uteri externum (indicated by bristle).
(From a specimen in Harvey Littlejohn's Museum in the University of Edinburgh.)

apart in development by abnormal shortness of the round ligaments. Piquand discusses the whole question of causation at length.¹ Since the clinical features of the uterus didelphys cannot be separated from those of the uterus bicornis they will be considered together.

Uterus Bicornis.—The uterus bicornis (also called *semi-uteri conjuncti* and *semi-uteri conglutinati*) is less rare than the uterus duplex; in it the two halves are united to some extent at their lower ends but remain apart at their upper (fundal) extremities (Fig. 114). This two-horned uterus stands therefore as the intermediate

¹ *Rev. de gynéc. et de chir. abd.* xv. 401, 466, 1910.

type between the completely separate semi-uteri (uterus didelphys) and the cases in which the organ is externally single but has an internal septum dividing it into two cavities. The chief external character of the uterus bicornis is the presence of the notch of separation at the fundus ; instead of possessing the ordinary rounded top the organ is split or divided, and the two horns thus produced diverge from each other towards the lateral pelvic walls. Where the divergence is most marked there are commonly two cervical portions united either by uterine substance or only by a bridge of connective tissue covered with peritoneum ; to these cases the name of *uterus bicornis bicollis* has been given (Fig. 115), and the two varieties have been termed *semi-uteri conjuncti* and *semi-uteri connexi*. In other instances the cervix is single (*uterus bicornis unicollis*), although the cervical canal may sometimes exhibit a septum. These more closely united semi-uteri have been termed *conglutinati*, or



FIG. 115.—Uterus bicornis, showing a double os uteri externum. (Harvey Littlejohn.)

congressi. In the least-marked type the fundus shows little more than a depression (*uterus cordiformis*). The vagina may be single or it may be more or less completely divided into two by a septum. One horn of the uterus bicornis may be pregnant as in Harvey Littlejohn's specimen (Fig. 116). The two uterine horns are seldom symmetrical either as regards position or size, and one of the two halves of the vagina also (when such exist) is generally much smaller than the other. In a certain proportion of cases (some authorities place it at 8 per cent) the *ligamentum recto-vesicale* is found between the semi-uteri. A degree of torsion may exist causing the two uterine bodies to lie one in front of the other rather than laterally ; the same occurrence may account for the vaginal septum running transversely as it sometimes does. The uteri may show sundry anomalies of structure : one or both halves may be solid or imperfectly canalized ; their cavities may contain retained blood (*haematometra*) ; the cervix may be imperforate, although in some cases of apparent solidity a small canal has been discovered by microscopic examination after the parts were removed ; and there may be one or more fibroid growths in

one or both horns. Finally, the uterine malformation may be associated with deformities of neighbouring or even of distant parts, such as displacement of the kidney,¹ ectopia vesicae, polydactyly, polymastia (Hennig),² and, in the case of foetuses, anencephaly, exomphalos, and cyclopia.

Clinical Features of the Uterus Didelphys and Bicornis.—Strange as it may seem, there is evidence that a woman with a double uterus may pass through her life and

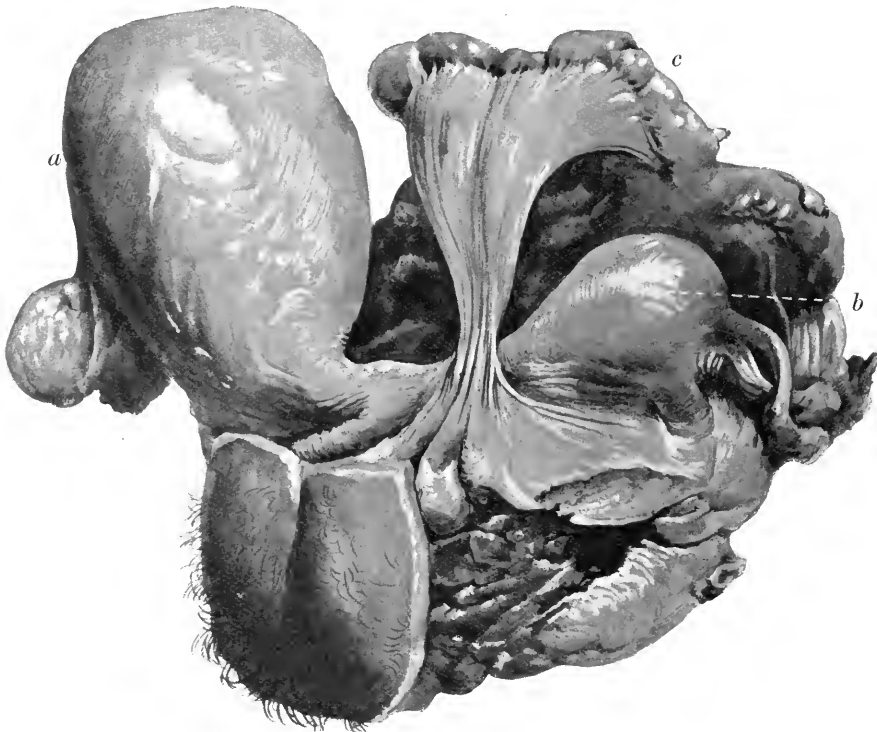


FIG. 116.—Uterus bicornis. (Littlejohn.)

a, Right half, which is pregnant; *b*, left half, which is non-pregnant and widely separated from the other; *c*, ligamentum recto-vesicale.

even bear children without its presence being suspected, and in the case of those who never marry it probably is more common for it to go unobserved than to be discovered. In any case the symptoms are elusive and the physical examination indecisive.

Menstruation appears to be seldom interfered with, and even when dysmenorrhoea or occasional amenorrhoea is present it cannot always be traced to the malformation, and it may be due to an associated morbid state. When one horn is imperforate, haematometra may develop, leading to the presence of a

¹ Hepburn, *Journ. Anat. and Physiol.* xxv. 24, 1890–91.

² *Arch. f. Anthropol.* xix. 185, 1890.

unilateral abdominal swelling and to monthly attacks of colicky pain ; the menstrual retention in these cases may be masked by the continued occurrence of the monthly discharge from the normal horn. On the other hand some exceptional instances of fortnightly menstruation may be explained by the presence of two semi-uteri which do not function synchronously but alternately.

Sterility is comparatively uncommon. Amongst the one hundred cases of women with didelphous or bicornute uterus collected by Scott Macgregor (*vide supra*) there were 70 who were married, and of these 56 had borne children and only 14 were nulliparous. Pregnancy may occur in one horn, whilst the other horn continues to menstruate, a condition which may serve to explain the occasional occurrence of a periodic red discharge during gestation (*e.g.* in L. P. Dodge's patient).¹ Each horn may be pregnant and twins be born at the same time (as in J. B. Hellier's patient)² or at different dates ; in the latter possibility lies the explanation of some at least of the supposed cases of superfoetation, as of that reported by J. H. Ross,³ in which the second child was expelled fifteen weeks after the first. Abortion is not uncommon, and there would seem to be a special tendency to the retention of the decidual membranes. When the horn in which the pregnancy has occurred is imperforate in its lower part, a condition of affairs comparable to ectopic gestation is brought into existence, and with it come all the risks of rupture and haemorrhage. Labour in the double uterus may, however, be uninterfered with, and the duplication of the uterus only be detected accidentally in the third stage. On the other hand, accidents, some of them very curious, have been reported : Halban,⁴ for instance, met with a case in which the pregnant horn lay obliquely to the empty one, and the head of the infant was driven through the septum between the two cavities. The vaginal septum in Gardini's patient⁵ was torn by the legs of the child coming down first on one side of it and then on the other, and it had in the end to be excised ; and in Ranken Lyle's observation the empty horn had a myoma in it which obstructed the delivery of the child in the other horn and necessitated the performance of Caesarean section. In Gardini's case the infant was also anencephalic, but it is hardly possible to connect the foetal and the maternal malformations in etiology, although the anencephalic state may have predisposed to the child presenting by the feet. It may be noted here that pelvic presentations seem to be more common in the double than in the single uterus. In Merlo's patient,⁶ labour was rendered very slow by the infantile state of the cervix (stenosis).

¹ *Northwest. Lancet*, x. 335, 1890.

² *Journ. Obstet. and Gynaec. Brit. Empire*, iii. 448, 1903.

³ *Lancet*, ii. for 1871, pp. 188, 215.

⁴ *Arch. f. Gynäk.* lix. 188, 1899.

⁵ *Ann. di ostet. e ginec.* xxi. 705, 1899.

⁶ *Ibid.* xxviii. 819, 1906.

It is not always easy to diagnose a double uterus with certainty ; but a careful bimanual examination will always suggest it. The presence of a double cervix or of two cervical orifices (Fig. 115), and more particularly the discovery of two vaginal canals, should invariably bring the thought of the uterus didelphys into the gynaeccologist's mind. If there are no symptoms or signs of pregnancy the sound or two sounds may be employed to clear up the diagnosis. The feeling of two uterine bodies with a sulcus between them of course indicates a double uterus, but the rarity of the malformation and the tendency of the medical man to think of a fibroid tumour or of tubercular tubes has often led to confusion. The so-called angular pregnancy of Wasilieff, in which the gestation sac is inserted over the opening of a Fallopian tube in the top corner of the uterus, may very closely simulate a uterus bicornis as in the case of Devraigne.¹ When one of the two bodies swells periodically, and when this monthly swelling is accompanied by pain, the gynaeccologist should suspect not only a double uterus but also one with haematometra in an imperforate half. With all diagnostic acumen, however, even the specialist's conclusion is not often reached until the abdomen has been laid open by laparotomy.

Attempts to treat double uterus formerly were few and somewhat ineffective if not actually dangerous. In the cases of retention of menstrual blood in an imperforate half-uterus it was customary to try puncture or vaginal incision, but the mortality was too high to warrant such interventions, although it must be admitted that gynaeccological asepsis was not practised at that time. In such conditions of haematometra abdominal section is to-day to be preferred. The particular procedure may be oöphorectomy, although the knowledge now possessed of the value to the woman of her ovaries makes the operator loath to choose it ; a better plan is subtotal or pan-hysterectomy of the semi-uteri ; but the best method is supravaginal hysterectomy of the affected half organ, recommended by Georges Gross,² for this gets rid of the dangerous condition, and at the same time conserves or may conserve the genital functions. In 1913 Gross and Fruhinsholz³ were able to collect 18 cases of subtotal hemi-hysterectomy for lateral haematometra in double uterus, and to add to the list another case (operated on by Gross) in which a normal pregnancy and labour followed in the remaining half-uterus.⁴

Apart altogether from haematometra the double uterus may become the objective of surgical interference, not indeed because of the malformation but on

¹ *La Gynécologie*, xviii. 15, 1914.

² *Thèse de Nancy*, 1899-1900.

³ *Ann. de gynéc. et d'obstét.* 2nd s. x. 507, 1913 ; xi. 230, 1914.

⁴ *Soc. d'obst. et de gynéc. de Nancy*, May 21, 1913.

account of some morbid state which has attacked the organ or its adnexa. Thus, a double uterus may call for curetting to cure an endometritis set up by an abortion, and then it will be well to curette both cavities. Inflammatory affections of the tubes and ovaries may be met with of a gonorrhoeal or septic nature. When there is duplication of the vagina as well as of the uterus the infection may be restricted to the tube and ovary of the one side, but if there is a common vagina or cervix it will doubtless affect both sides. In such patients medical means must first be tried, but later salpingo-oöphorectomy may be needed, either unilateral or bilateral. As a rule there will be no need to perform hysterectomy. Fibroid tumours may occur in association with a double uterus. Viannay (as stated by Goullioud) operated on one as large as a man's head, and during its removal was alarmed to find he had opened into a cavity which he at first regarded as the bladder and then discovered it to be the second vagina ;¹ and, as already noted, a fibroid attached to the empty half-uterus has prevented the delivery of the child from the pregnant half and necessitated Caesarean section. So, too, operations have been called for in the case of cancer or sarcoma of the double uterus or for marked displacements of one or both halves (Goullioud).²

In all operative work upon the uterus didelphys and uterus bicornis the gynaecologist must bear in mind the peculiarities of the anatomy. There is, for instance, only one uterine artery at the right and left side, so that no more arteries require to be tied in a hysterectomy upon a double than in one upon a single organ. Again, the broad ligament is not always well marked, and one may have to incise the peritoneum covering the half-uterus in order to enucleate it. Yet again, one must not forget the frequent existence of a recto-vesical fold stretching between the two semi-uteri, measuring in some cases from 3 to 5 inches, and having two small arteries in it ; it can be seen and easily dealt with in the abdominal operation, but may prove a great hindrance and cause confusion in vaginal hysterectomy. Further, the anomalies of the kidneys (single displaced kidney) and of the ureters (absence, two on one side, etc.) which are apt to be associated with double uterus must not be overlooked by the surgeon.

Uterus Septus.—The septate uterus (*u. septus, bilocularis, globularis*), although it may give externally no indication of its double character, save perhaps an unusual breadth of fundus, is nevertheless another instance of lack of fusion of the Müllerian ducts causing duplication (*vide* Fig. 117) ; for if it be cut open it will be found to have two cavities (right and left) divided by a complete antero-posterior, vertical septum. When the septum does not reach the whole length of the organ the condition

¹ *Ann. de gynéc. et d'obstét.* 2nd s. ix. 734, 1912.

² Goullioud, *loc. cit. supra*.

is classified as one of *uterus subseptus* or *semi-partitus*; when it exists in the cervix as well as the body of the uterus but leaves a single os uteri externum it is known

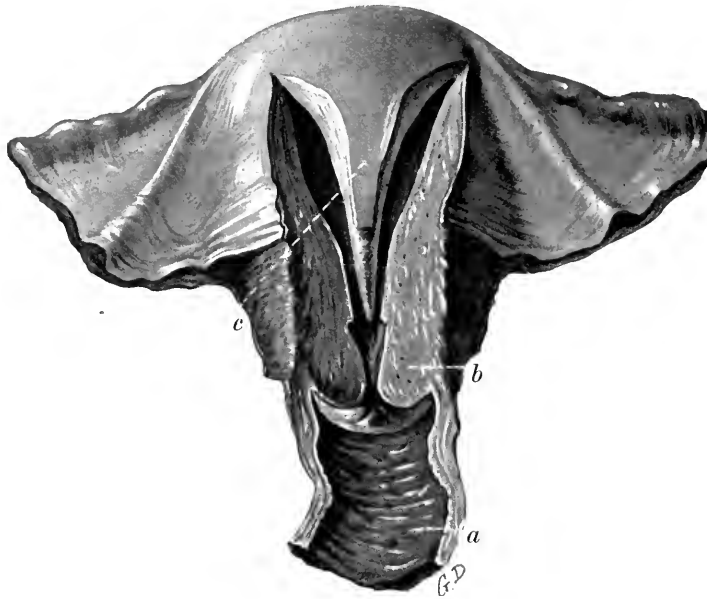


FIG. 117.—Uterus subseptus.
a, Vagina; b, cervix; c, septum.

as *u. subseptus uniforis*; when there is no septum in the cervix it is *u. subseptus unicollis*; when it is present only in part of the body it is called *u. subseptus unicorporeus*; and when it is found only near the os externum it is named *u. biforis supra simplex*. This enumeration of varieties will also serve as a short description of the morbid anatomy of the uterus, but it remains to be noted that this malformation may be associated

with fibromyomata, as in two cases reported by Alban Doran and Cuthbert Lockyer¹ (although these writers are of opinion that double uteri are less prone to harbour tumours of clinical importance than are normal uteri); with carcinomata, as in a patient operated on by Buist and Valentine;² with haematometra; and with haematosalpinx. Double vagina is also not uncommonly present.

In their clinical features cases of uterus septus do not differ markedly from uterus didelphys and bicornis, and much that has been stated about the latter need not be repeated. Diagnosis is hardly ever made from physical examination unless there is a double cervical orifice or vagina to suggest the deformity; then the unusual breadth of the fundus, and the fact that the sound (or two sounds) can be passed up into separate uterine cavities may reveal the nature of the case. But the diagnosis may be accidentally made during intra-uterine manipulations, such as clearing out the products of an abortion (as in R. C. Buist's cases,³ in which the incomplete nature of the septum gave the operator the impression of a uterine rupture), or removing a placenta, or performing version. Pregnancy does not seem

¹ *Journ. Obstet. and Gynaec. Brit. Empire*, vii. 167-186, 1905.

² *Ibid.* xxv. 88, 1914.

³ *Brit. Med. Journ.* i. for 1914, p. 907.

to be uncommon in the septate uterus, and curiously enough, the proportion of twin pregnancies is high. Jellinghaus,¹ from an analysis of 52 cases of double uteri (including all the three types—didelphys, bicornis, and septus), found twins once in 12 pregnancies instead of once in 89 or 90 (the usual proportion); further, such twin pregnancies rarely reached full term, although when one foetus was expelled there was always a fair chance that the other might go to the full time; again, when both twins were born, it was common for there to be an interval, not of hours but of days, between them, Jellinghaus stating that when birth took place at term, in nearly half the cases there was an interval of more than seven days between the two births. Paulin,² for instance, met with a patient who was delivered of a second child 17 days after the first; after the birth of the first no lochia came away and the breasts secreted no milk, but after the second child was born the lochia flowed freely, and there was enough milk to suckle both children. The presence of the septum increases the danger and difficulty of labour and the risks of the puerperium; thus, if the placenta be inserted on the septum, post-partum haemorrhage is predisposed to. One must keep in mind, too, the thinness of the uterine walls which is present in some cases of uterus septus and may lead to rupture. Yates and Morse³ have recorded a case of hyperemesis gravidarum in which there was a uterus septus (Fig. 118).



FIG. 118.—Case of pregnancy in a uterus septus.
(After Yates and Morse.)

Uterus Unicornis.—The uterus unicornis is linked on to the uterus bicornis by the intermediate type known as the uterus unicornis with a rudimentary horn on the opposite side (*uterus unicornis cum rudimento cornu alterius solidi seu excavato*).

¹ *Bull. Lying-in Hosp., New York*, v. 37, 1908.

² *Hospitalstidende* (Copenhagen), R. iv. xii. 145, 1904.

³ *Amer. Journ. Obstet.* lxxvii. 347, 1913.

There is no clear line of demarcation, for the uterus bicornis in which one horn is incompletely formed (*e.g.* not fully hollowed out) is hardly to be separated



FIG. 119.—Uterus unicornis. (Harvey Littlejohn.)

The body of the uterus, inclined to the right, has been laid open; on the left side the Fallopian tube (*F.T.*) and an elongated ovary (*o*) are seen.

from the unicornute organ with a rudimentary horn attached thereto. Nevertheless one meets occasionally with a uterus unicornis in which there is nothing but the single horn, inclining to the side and tapering to a point, at which it becomes continuous with the Fallopian tube and gives attachment to the round ligament (*vide*

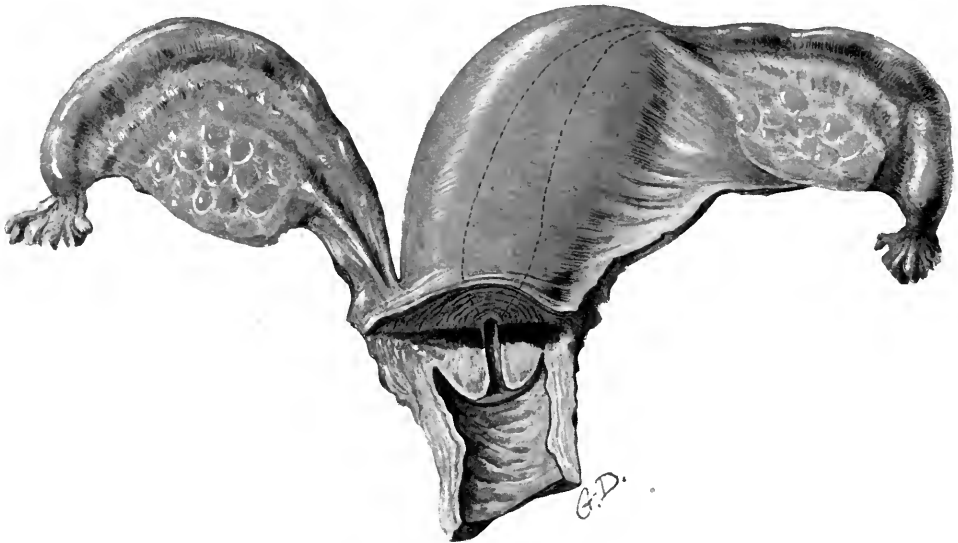


FIG. 120.—Uterus unicornis, showing the attachment of the undeveloped horn at the level of the internal os.

Figs. 119, 120); the vagina is absent, narrow, or septate (Czyzewicz), and the cervix small, or not to be felt at all *per vaginam*, as in Cuthbert Lockyer's patient.¹ The ovary on the same side as the developed horn is usually found, but that of the opposite

¹ *Journ. Obstet. and Gynaec. Brit. Empire*, xiii. 359, 1908.

side may be wanting or be imperfectly developed, as in Czyzewicz's case.¹ Unilateral defect may also be noted in the tube, broad ligament, kidney, and bladder. In Lockyer's case (*loc. cit. supra*) the Fallopian tube was retroperitoneal in position and was distended with blood; there was likewise haematometra in the single horn. Natanson's account of the pathology and pathogenesis of this uterine malformation may be usefully consulted.²

When a patient is possessed of a uterus unicornis her menstruation may be absent, lessened in amount, accompanied by pain, or practically normal; pregnancy may occur in the single horn, and the malformation pass unnoticed. In L. C. Panting's case³ the presence of a uterus unicornis was discovered during an appendicitis-operation. If, however, there be a rudimentary horn on the opposite side, and if it become pregnant, or if the single horn itself be poorly developed and contain a gestation, then the conditions are similar in gravity to those surrounding an ectopic pregnancy (rupture, intraperitoneal haemorrhage, etc.). Diagnosis is always difficult, but the presence of the unicornute uterus may be suspected from its lateral position and marked inclination to one side; commonly it is not recognized till it becomes pregnant and gives rise to dangerous symptoms necessitating abdominal section. Operative treatment will in most cases take the form of hysterectomy, for the uterus unicornis has seldom any high reproductive value, and if it be imperfectly developed it is accompanied by dangers from haematometra and rupture during labour, which makes it safer to remove the organ. Operating by abdominal section on a patient pregnant for the third time, Fruhinsholz and Job⁴ found that the gravid uterus was of the unicornute variety; there had been delay in labour and infection, so the Caesarean section was followed by hysterectomy, or hemihysterectomy to be quite exact.

Uterus Rudimentarius.—The name uterus rudimentarius has been given to a somewhat ill-defined entity, for, of course, the uterus bicornis and the uterus unicornis may, in addition to their characteristic features, show a certain degree of poverty of development. The rudimentary uterus, so far as it is capable of definition, is a body of variable form, consisting of fibrous, muscular, or fibro-muscular tissue, in some cases solid, in others showing a slight cavity (*uterus rudimentarius solidus*, *u. rudimentarius partim excavatus*), and occupying the position of the normal organ. All that is to be discovered in some cases is a small piece of solid muscular tissue lying between the layers of the two broad ligaments, which in these cases sweep almost unbrokenly from one side of the pelvis to the other; but it is

¹ *Zentrbl. f. Gynäk.* xxx. 1284, 1906.

³ *Brit. Med. Journ.* ii. for 1912, p. 121.

² *Monatsschr. f. Geburtsh. u. Gynäk.* xx. 1195, 1904.

⁴ *Ann. de gynéc. et d'obst.* 2nd s. xi. 237, 1914.

convenient to include here also the cases in which the uterus has a cavity surrounded by thinned-out walls (*membraniform uterus* or *uterus membranaceus*). The adnexa may also be defective, and the vagina may be solid or narrow. The external genitals may be normal, but K. J. Bucura¹ has reported an instance of *anus vestibularis* in association with *uterus rudimentarius cum vagina rudimentaria solida*. The mammary glands may be normal or small in size, and the hair on the mons veneris may be scanty (as in Falk's patient).² The clinical features, diagnosis, and treatment of rudimentary uterus cannot be separated from those of absent uterus, and will therefore be considered along with that anomaly. It may be noted, however, that Weisswange³ has reported vicarious menstruation (epistaxis) in a case of rudimentary uterus in a girl nineteen years old.

Defectus Uteri.—The complete absence of the uterus in an individual who possesses ovaries and all the other parts and characters of the female sex, is very rare; but persons with defect of the uterus, the tubes, and the vaginal canal (the Müllerian derivatives) are occasionally met with. If such persons have genital glands and the secondary sexual characters of the female they have been classified as women; but recently some doubt has been thrown upon this method of grouping them. Blair Bell has referred to the patient under the care of H. Russell Andrews who, but for the absence of the uterus, tubes, and ovaries, was possessed of every female characteristic, yet inside the abdomen were found two testes. Such a case, whilst it gives some support to the view that the ductless glands (endocrinous organs) may aid in the development and maintenance of the sexual characters, seems to show that the genital glands (ovaries and testicles) are not so all-powerful as was supposed in determining sex-appearances. Still, from the practical standpoint, the individual with female characteristics, even if possessed of intra-abdominal testicles and without a uterus, is often conveniently regarded as a woman. It has to be borne in mind that, short of making a complete examination of the whole abdominal cavity (hardly ever possible in a laparotomy), it is very difficult to determine with accuracy what genital glands are present and where they are situated; a rudimentary uterus, too, may be found in an unexpected position.

If Fallopian tubes are present when the uterus is wanting, they are commonly little more than rods of tissue, with perhaps an abdominal ostium. If they are absent, the peritoneum passes directly from rectum to bladder; their presence raises it up into slight folds or mesenteries, scarcely worthy of the name of broad ligaments. Round ligaments can usually be traced, ending in the tissue between the

¹ *Wien. klin. Wochenschr.* xix. 1007, 1906.

² *Zentralbl. f. Gynäk.* xxx. 429, 1906.

³ *Ibid.* xxvii. 581, 1903.

bladder and the rectum. Whilst the vulva is often normal, and a vestibular canal (deepened by attempts at coitus in the married woman) exists, it is very common to find that there is no vagina. The mammae may be ill-developed, as may the hair of the vulva; but, as has been said already, all the secondary sexual characters may be evident (feminine voice, breadth of pelvis, etc.). It is important to remember the possibility of the existence of other structural anomalies; T. S. Cullen,¹ for instance, thought that a mass he felt in the pelvis was a distended uterus or vagina, so he made a dissection up from the vulva, separating the bladder and rectum, only to find the mass solid; he then opened the abdomen, discovered the solid swelling to be the right kidney lying in the pelvis, with no left kidney, and the uterus absent; both ovaries (?) were in the inguinal canals.

The clinical features of absent and rudimentary uterus are in some respects fairly constant. Amenorrhoea, for instance, is almost always noted, although Alexander Brown² reported a case in which no uterine body could be felt (under an anaesthetic), and yet normal menstruation occurred from the cervix. Sterility is constant; sometimes there are severe periodical flushings, headaches, backaches, and other menstrual molimina; and sexual desire may be present or absent. Painful swellings may appear each month in the groins or iliac regions,³ pointing to herniated ovaries in a functional state. Vicarious menstruation, or something which is regarded as of the nature of xenomenia, has been observed, most commonly in the form of epistaxis (Brettauer).⁴ Even in the patients with absence of the vaginal canal, a degree of coitus is sometimes possible, for attempts at cohabitation by the husband deepen the vestibular canal, and occasionally cause dilatation of the urethra; but connection is generally attended by pain. Family prevalence has been recorded by Napoleon Boston,⁵ who met with absence of the uterus in three women who were sisters, and in two who were cousins. Whilst the diagnosis of complete absence of the uterus is practically impossible without an abdominal section, that of rudimentary uterus is comparatively simple; for by passing a finger up the rectum, introducing a sound into the bladder, and having the abdominal wall firmly depressed above the symphysis pubis, it is easy to determine that there is nothing like a fully-formed organ between the rectum and the bladder. Treatment must vary with the circumstances. Blood-tonics are seldom of the least assistance. When severe suffering is present at monthly intervals, it may be best to perform oöphorectomy (as in Harlan's case); the presence of a rudimentary, solid, or semi-solid uterus may call

¹ *Surg. Gynec. and Obstet.* xi. 73, 1910.

² *Lancet*, i. for 1909, p. 1456.

³ Harlan, *Journ. Amer. Med. Assoc.* xlviii. 519, 1907.

⁴ *Amer. Journ. Obstet.* lvi. 867, 1907.

⁵ *Lancet*, i. for 1907, p. 21.

for hysterectomy,¹ more particularly when it has a cavity containing blood-clot (haematometra), and of necessity when the blood has become pus (pyometra). The vaginal condition and its treatment will be considered later ; meantime it may be mentioned that both Cullen and Brettauer, in attempting to work up between the bladder and rectum towards a supposed uterus (with haematometra), came upon a displaced kidney, which, as it turned out, was the only one which the woman possessed. Care must always be taken in essaying to establish a connection between the vulva and a rudimentary uterus.

Uterus Foetalis.—When the uterus retains in post-natal life the characters which were peculiar to it in the later part of ante-natal life, it is said to be a *uterus foetalis* ; in other words, the developmental changes which normally occur after birth do not ensue, and the organ is left of the foetal type. The cervix is longer than the corpus, its walls also are thicker than those of the body ; the whole uterus has the form of an inverted ninepin, and is small in size (the sound only enters to a depth of an inch or an inch and a half) ; the cervix is conical and has a narrow os ; and the mucous membrane of the corpus as well as of the cervix is thrown into folds. The Fallopian tubes sometimes show persistence of their ante-natal spiralities, and the ovaries retain their elongated narrow form ; the vagina, too, may be narrow and short, and the mammary glands poorly developed. There may be a small amount of fat in the labia majora, and the clitoris may show some hypoplasia.² There may be other associated malformations, such as uterus bicornis, cloacal formation, etc. The term *uterus infantilis* is sometimes employed as a synonym, at other times a distinction, although a fine one, is drawn : in the infantile organ it is stated that the folds in the mucosa are restricted to the cervix, whilst in the foetal uterus they exist in the body as well.

Clinically, the *uterus foetalis seu infantilis* is marked by amenorrhoea (rarely by scanty and painful periods), by sterility, and commonly by absence of sexual appetite or libido. All the changes which have been grouped under the general term *infantilism*, or, better perhaps, *foetalism*, may be associated, and hypoplasia of the heart and vessels, chlorosis, the status thymo-lymphaticus, and a tendency to phthisis are often noted. Diagnosis of the uterine malformation is made by a careful bimanual examination, if necessary under an anaesthetic ; special attention must be paid to the state of the cervix, for it is larger in relation to the body of the organ in the uterus foetalis than in the uterus pubescens (to be next described). Treatment is seldom of much value, and when the oligomenorrhoea is accompanied by

¹ Goullioud, *Ann. de gynec.* 2nd s. ix. 604, 1912.

² Dietrich, in Schwalbe's *Morphologie der Missbildungen*, Pt. iii. sect. vi. p. 45, 1911.

severe pain, the operations of oöphorectomy or of hysterectomy may have to be faced.

Uterus Pubescens.—In the uterus pubescens the characters which are quite normal in the child before the *menarché*, persist after the establishment of menstruation, when, of course, they ought to have given place to those of the virginal adult organ. In other words, it remains small in size, has a body and cervix of nearly equal length, and is associated with tubes, ovaries, and external genitals of the child type. Sometimes a *uterus virgineus* is distinguished from the uterus pubescens; in it (the *u. virgineus*) the difference may be one of size alone, the organ being hypoplastic, and possessing a poor musculature, or it may be one of inequality, the organ being better developed on one side than on the other. The symptomatology and diagnosis are closely similar to those of the uterus foetalis; but amenorrhoea is not so complete, and there is always a hope that the sexual stimulus following upon marriage may yet cause increased growth of the organ and a better performance of its functions. It is doubtful, however, whether marriage should be counselled unless menstruation is present in some measure.

Atresic States of the Uterus.—It is seldom that a uterus which is well formed and of normal size shows any trace of atresia, whilst a more or less marked degree of imperforation is common in the uterus unicornis and rudimentarius. Occasionally, however, cases have been met with in which some slight atresia has been found as an independent malformation. Most commonly the block is found in the cervix, or at the isthmus of the uterus, and, theoretically at least, it may be due to the lack of canalization of the ducts of Müller in one localized spot, to adhesions in the cervical canal between opposing epithelial surfaces, or to cicatricial union following upon foetal endocervicitis of an infectious origin. The atresia may be situated in the isthmus, leaving the body open above and the cervix pervious below, or it may be at the internal os, at the external os, or at both, or at some point between the two. No further pathological changes need take place until puberty, when, with the commencement of menstruation, there will be a gradual production of haematometra, and there may be, superadded to this, haematosalpinx and possibly haematocoele. When the atresia is at the internal os the body of the uterus alone will be distended, the cervix remaining unaltered in every way, but when it is in the cervical canal or at the external os the cervix will be more or less solid, or will show a rounded mass with a blood-containing cavity.

The clinical features of such localized atresias as have been referred to are quite simple. There will be complete amenorrhoea from the time of puberty, accompanied by more or less severe periodical suffering in the lower part of the abdomen.

and the gradual development of a uterine swelling (haematometra). The bi-manual examination will reveal the swelling of the uterus, perhaps also of the tubes ; and

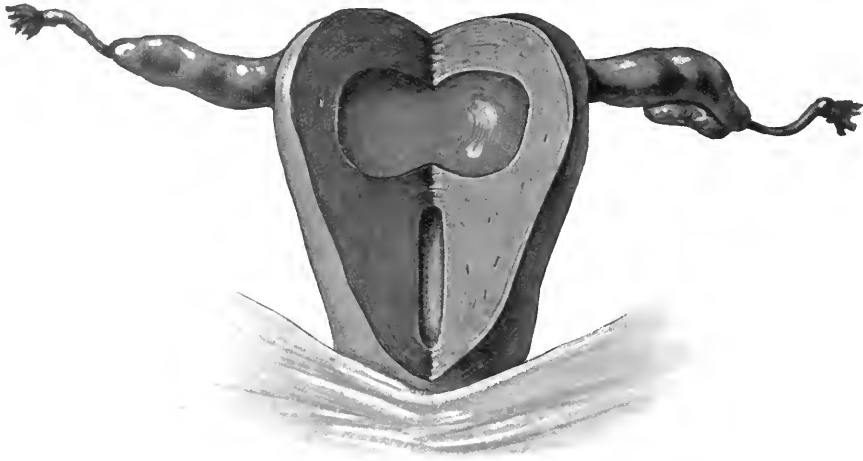


FIG. 121.—The operation of trachelostomy. (After Goullioud.)

First stage.—The closed uterine cavity and the independent cervical one exposed.

the vaginal touch will show one or other of the states of the cervix which have been named above. It will be impossible to pass a sound fully into the uterine cavity.



FIG. 122.—The operation of trachelostomy.

Second stage.—Reunion of the two cavities by excision of intervening tissue.

In a few cases the vault of the vagina itself may be imperforate. The rectal touch will then enable the distended uterus to be palpated. Goullioud¹ has recently attempted to systematize the operative treatment to be carried out under various

¹ *Ann. de gynec. et d'obstet.* 2nd s. ix. 700, 1912 ; and *Thèse*, Lyon, 1911.

circumstances. The objects to be attained are relief of the haematometra, with the establishment of a permeable cervical canal and the conservation of the patient's

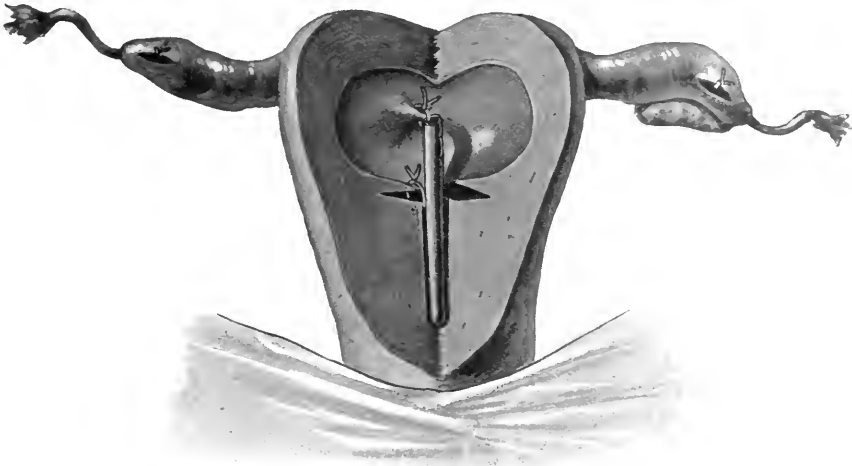


FIG. 123.—The operation of trachelostomy.

Third stage.—Bringing together of the two mucous surfaces.

sexual organs, and, if possible, her reproductive powers. Naturally enough these aims are not always easy of accomplishment; but the sufferings of the patient

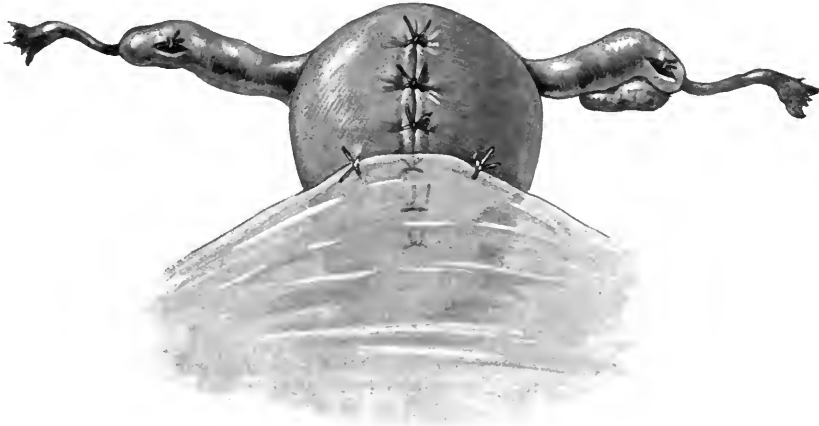


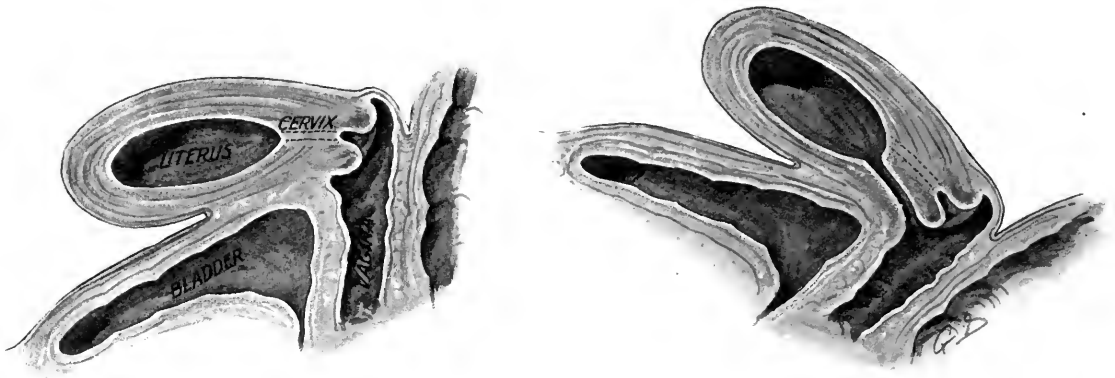
FIG. 124.—The operation of trachelostomy.

Fourth stage.—Closure of uterine incision, which is covered partly by peritoneum from the utero-vesical pouch.

call for operative interference, and the common way chosen, namely the removal of the ovaries, is certainly not the best conceivable. It must be remembered that most of the patients are quite young.

For an imperforate state of the isthmus Goullioud recommends trachelostomy

in preference to blind attempts to pass a probe or other instrument up from the vaginal and cervical canals through the block into the uterine cavity. An abdominal section is performed; the bladder is separated from the uterus, and a vertical incision is made in the anterior wall of the latter, opening into the haematometric cavity, and exposing the atresia; a communication between the uterine and cervical cavities is established by excising a wedge-shaped portion of the fibrous tissue, and bringing the mucous membrane of the body into touch with that of the cervix, so as to establish continuity of mucous surfaces; the uterine incision is then closed, and, if need be, a salpingostomy may be done to give escape to the blood in the haematosalpinx. Goullioud senior performed this operation successfully, and gave to it the name of *abdominal trachelostomy* (*vide* Figs. 121, 122, 123, and 124).



First stage.

Second stage.

Figs. 125, 126.—Hofmeier's operation of hystero-elytrostomy. (After Goullioud.)

For the cases in which the cervical canal is replaced by a block of fibrous tissue, the treatment formerly employed was incision of the haematometra from the vagina, an operation which, although apparently simple, was apt to be followed by ascending infection and even by death. Tapping of the blood-accumulation in the uterus with a trocar is still more uncertain in its results, and dangerous in its technique. M. Hofmeier¹ was the first to suggest a more scientific method of dealing with the haematometra, resulting from cervical imperforation. From the vagina he made an opening into the bulging haematometra, not directly through the fibrous piece of occluding tissue, but to one side of it (*vide* Figs. 125, 126); in this way he established a uterine fistula, and sutured the mucous membrane of the uterus to that of the vagina. The operation is known as *hystero-elytrostomy*. Goullioud (*loc. cit.*), on the other hand, recommends a large resection of the interposed block of fibrous

¹ *Ztschr. f. Geburtsh. u. Gynäk.* lii. 1, 1904.

tissue, so as to open into the cavity of the haematometra and coapt the two mucous membranes. In both these operative procedures it may be found necessary to open the abdomen in order to determine the state of the adnexa, for if there is haematosalpinx, the risks of ascending infection and peritonitis are much increased, and to prevent them it will be needful to remove the tubes.

The cases in which the vagina and the uterus are completely shut off from one another scarcely fall under the heading of uterine atresia, but rather under that of vaginal imperforation; a word or two may be said about them here. Halban¹ met with an instance of this kind, in which the uterus, distended with blood, was

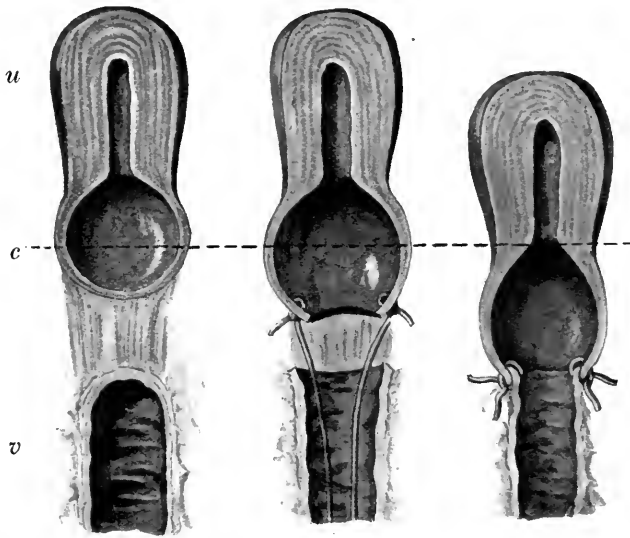


FIG. 127.—Hofmeier's method of establishing communication between the uterus and the vagina.
(After Goullioud.)

u, Uterus; *c*, dilated cervix; *v*, vagina.

separated from the vagina by an interval too great to be pierced through; with great ingenuity he opened the abdomen and turned the uterus upside down so that its fundus was brought into contact with the vaginal roof, he then opened into the uterine cavity at the fundus and into the vagina at its roof, and sutured the two cavities together. It may be added that there was no risk of a pregnancy since the adnexa were diseased. Even in these difficult cases, however, it is not hopeless to attempt to establish communication between the vagina and the uterus, and to conserve the functions of the latter. Hofmeier (*loc. cit.*), for instance, did an operation in three stages (*vide* Fig. 127): First he approached the imperforation from the vaginal aspect, and began the separation of the rectum from the

¹ *Ztschr. f. Geburtsh. u. Gynäk.* xlix, 17, 1903.

bladder; then he opened the abdomen, completed the separation, opened the lower part of the haematometra, placed two silk sutures on the margins of the opening, and passed them through into the vagina; and finally from the vaginal aspect again he drew down the sutures and the uterine opening, and stitched the cervical to the vaginal mucosa. In many cases the operative plans which have been described may be too difficult of accomplishment; hysterectomy with the preservation of an ovary is then the best treatment.¹

Minor Malformations of the Uterus.—Sometimes stenosis of the cervix of a congenital kind is found, the sound passing in only with difficulty; at other times there is a transverse septum or diaphragm in the cervical canal. In the one case dilatation is called for, and in the other excision of the septum or diaphragm. Dysmenorrhoea may be complained of in either case. The os uteri externum

may be divided into two openings by a frenum (*uterus biforis*), a condition which is normal in the ant-eater (Pozzi); and this malformation may exist without any other sign of duplication of uterus or vagina. It may conceivably give rise to trouble in labour, and the frenum may require excision. Apart from atresia the cervix may be small (*uterus parvicollis*) or absent (*uterus acollis*).

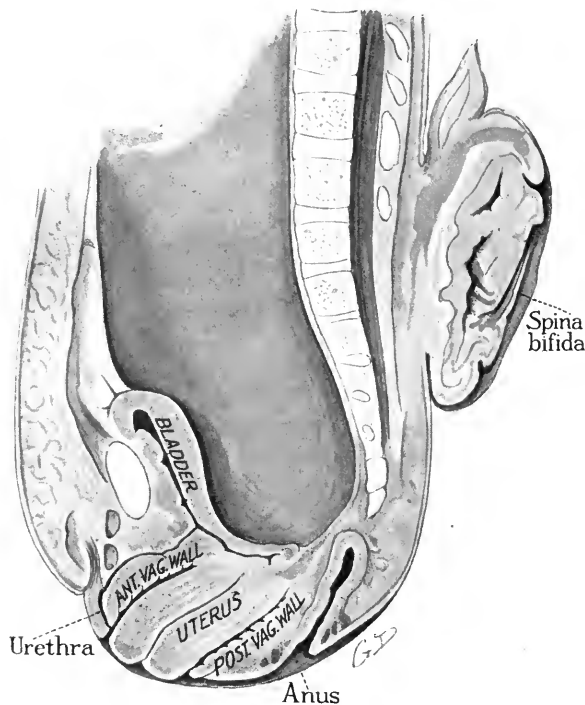


FIG. 128.—Case of congenital prolapsus uteri with spina bifida. The uterus lies below the level of the pelvic outlet, and is retroverted. (Ballantyne and Thomson.)

may be divided into two openings by a frenum (*uterus biforis*), a condition which is normal in the ant-eater (Pozzi); and this malformation may exist without any other sign of duplication of uterus or vagina. It may conceivably give rise to trouble in labour, and the frenum may require excision. Apart from atresia the cervix may be small (*uterus parvicollis*) or absent (*uterus acollis*).

Slight changes in the form of the fundus occur. There is the anvil-shaped uterus (*uterus incudiformis seu biangularis*), in which the normal convexity of the fundus is lacking, and a straight line joins the two Fallopian tubes; and closely allied to it is the uterus, with the flat fundus (*uterus planifundalis*). Congenital prolapsus uteri is a very rare anomaly. Since 1897, when Thomson and the present author,² reported two (*vide* Fig. 128) and summarized the six previously recorded instances, the number has been more than doubled, but

¹ Bérard, *Lyon méd.* cxvii. 493, 1911.

² *Amer. Journ. Obstet.* xxxv. 161, 1897.

yet it remains one of the least frequent of uterine anomalies. The association of the displacement with spina bifida of the lumbo-sacral region, whilst not constant, has been so common as to suggest some causal connection; and there is some evidence that spina bifida is accompanied by changes in innervation, and by a thinning and weakening of the levatores ani muscles, which would serve in part to explain the falling down of the uterus.¹ Congenital descensus is a true prolapse of the uterus, and must be distinguished from congenital hypertrophic elongation of the cervix; and the distinction can usually be made quite easily by noting the length of the vaginal canal and that of the uterus itself. There may be some degree of rectal protrusion as well, and associated deformities are clubfoot and spina bifida.

Abnormal communications between the uterus and neighbouring organs will be considered under the malformations of the vulva and lower part of the vagina.

ANOMALIES OF FORMATION OF THE VAGINA

It is now generally admitted that the development of the vagina is not so simple as was once supposed; the fusion of the lower parts of the two Müllerian ducts does not lead to the formation of the whole canal, but only to that of its upper portion, and probably, as Berry Hart maintains with some interesting and weighty embryological evidence,² its lower third takes its origin in the coalescence of the Wolffian bulbs and the urinogenital sinus. If this be so, then various complicated arrangements of parts in the neighbourhood of the vaginal orifice, and all the cloacal deformities become easier of comprehension; it is simpler, for instance, to understand how the upper two-thirds of the vagina may be lacking, whilst the lower third is present.

Double Vagina.—With the vagina, as with the uterus, what is commonly called duplication is really lack of fusion of the two Müllerian ducts; in the case of the double vagina it is in their lower stretches that the ducts have failed to unite. At the same time, true duplication of the vagina may occur, although with great rarity. It is seen in the case of some pygopagous female twins, and there are a few cases in which it may be hazarded that the only evidences of the fusion of two female foetuses are to be noted in the pelvic region. Thus, in Suppiger's little patient (a girl of 21 months) there was duplication of the lower end of the vertebral column, of the bladder, the uterus, the rectum, of the vulva, and of the vagina; and it seems necessary to postulate something more, in such an arrangement of parts,

¹ W. von Radwanska and R. Graf, *Gynäk. Rundschau*, vii. 515, 1913; *Monatsschr. f. Geburtsh. u. Gyn.* xxxiv. 645, 1911.

² *Trans. Edin. Obst. Soc.* xxvi. 259-305, 1901.

than a mere failure of the Müllerian ducts to unite.¹ So, too, in the adult married woman (*vide* Fig. 129) described by J. E. Gemmell and A. M. Paterson:² she had an unusually wide pelvis, there were two separate vulvae, two vaginae, two uteri (each of which had been pregnant), and two bladders, but only one anal aperture; the pubic bones were widely distant in front, a circumstance which made labour very easy. The vaginal canals did not lie side by side as in the ordinary cases of uterus didelphys and vagina septa, but rapidly diverged, and the two uteri lay far apart in the “enormously wide” pelvis.

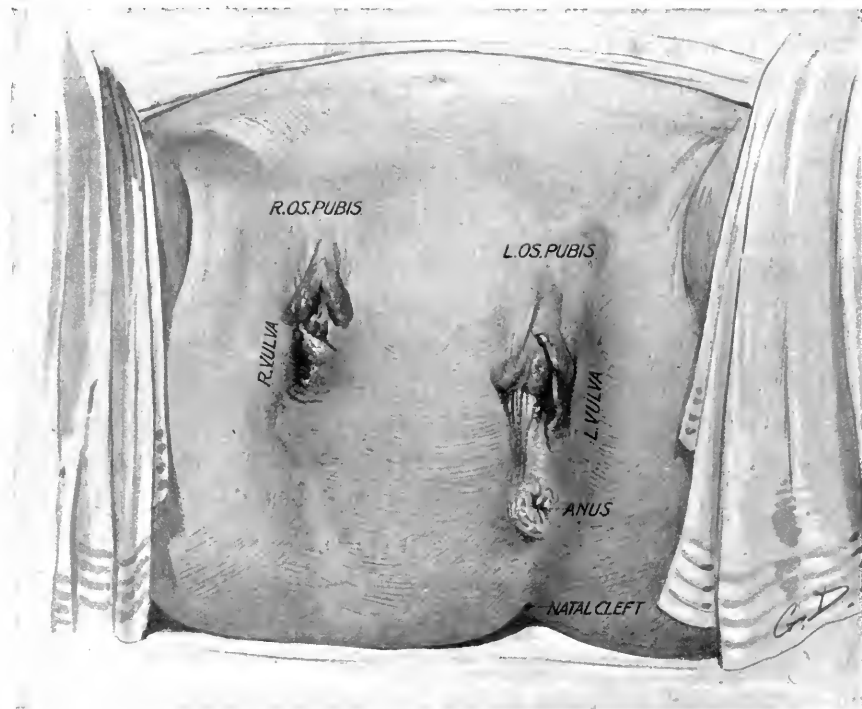


FIG. 129.—Case of double vulva, vagina, and uterus. (After Gemmell and Paterson.)

Far commoner are the cases of double or *septate vagina*, in which the vulva is single or at most there are two hymeneal openings. The two vaginal canals are separated by a longitudinal septum, running in the great majority of cases antero-posteriorly, as in Barozzi and Fournier's patient³ (*vide* Figs. 130, 131), and only rarely in a transverse direction; the canals, therefore, are generally lateral in their relation to each other, and not often one in front of the other. The vaginae are rarely of the same size and form, one being smaller and narrower than the other,

¹ *Correspondenzbl. f. Schweizer. Aerzte*, No. 14, p. 418, 1876; and No. 24, 1878.

² *Journ. Obst. and Gyn. Brit. Emp.* xxiii. 25, 1913; xxiii. 139, 1913. ³ *La Gynécologie*, xviii. 197, 1914.

and lying to some extent to the side of it. The septum differs in thickness and structure, but in its most complete form it is made up of muscular tissue covered on each side by mucous membrane. It may be defective above or, more often, below, leading to the two varieties, *vagina septa infra* and *vagina septa supra*; or, in rare cases it may show perforations at places. As has been stated already (*vide* p. 237), the uterus may be double, and belong to the didelphous, bicornute, or



FIG. 130.—Case of double vagina. (After Barozzi and Fournier.)

septate type; indeed it is somewhat rare for the womb to show no sign of duplication. In Holste's patient,¹ however, the uterus was single. Sometimes the only indication of the double nature of the vagina is found in the presence of a ridge on the anterior and posterior wall, and these ridges are commonly all that is left after the septum has been divided in labour. One or both the vaginae may be atresic and may contain blood, setting up the condition known as haematocolpos (unilateral or bilateral).

¹ *Zentrbl. f. Gynäk.* xxxvii. 965, 1913.

Unless there is some degree of atresia, double vagina does not usually give rise to any symptoms drawing attention to it before marriage. If, however, one or

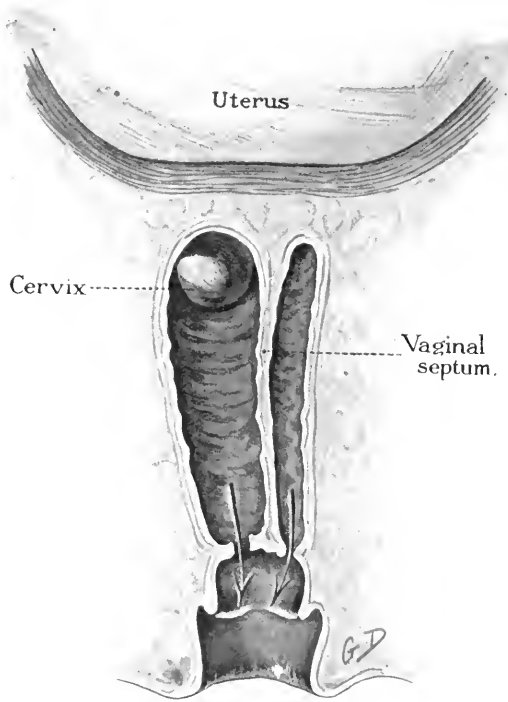


FIG. 131.—Case of double vagina. (After Barozzi and Fournier.)

Transverse section, showing the cervix opening into the right vagina whilst the left vagina ends in a cul-de-sac; the septum divides the two canals.

both cavities are imperforate below, then blood accumulates, monthly suffering follows, there may be a swelling felt through the vulvar aperture, and operation will be required to relieve the condition. Dyspareunia has been reported, and is due to narrowness of the canal. Sterility may result from the dyspareunia, or from intercourse taking place in that one of the two canals which has no cervix in it (Fig. 131). In other cases the malformation passes unnoticed till pregnancy has occurred (as in Barozzi and Fournier's case, *loc. cit. supra*), and labour is in progress; then various things may happen. The child may come down one canal, and the septum be pressed to the side and perhaps go unobserved; or the intervening tissue may first stretch and finally tear, and the rupture may extend into

neighbouring organs, with dangerous or disastrous effect; or the partition may be recognized during delivery, ligatured, and safely divided. Some curious occurrences have been chronicled. In Pierra's patient,¹ for instance, the uterus was bi-lobed, there was one cervix, and the vagina was divided into two canals by a thick septum, which ceased immediately below the cervix; the child presented by the breech (a not uncommon presentation in such cases), and the medical attendant drew down one foot into the right (the larger) vagina, only to find further progress arrested by the other foot having passed into the left canal; two long clamps were applied to the septum, which was divided between them; and the child, which had been astride the partition, was safely delivered. In Graarud's patient² there were two uteri as well as two vaginal canals, and both uteri had been pregnant.

¹ *Bull. Soc. d'Obst. de Paris*, xi. 236, 1908.

² *Norsk Mag. f. Laagevidensk.* 5 R. v. 1093, 1907.

Vouters,¹ in the case of a primipara, found a vaginal septum over 3 inches in length obstructing the progress of the child's head, and calling for division between two catgut sutures.

The *diagnosis* of double vagina does not, as a rule, present much difficulty: the finger passes up first one and then the other canal, or, if one be imperforate and dilated, it notes the swelling in the lateral wall; a finger can usually be passed on each side of the septum, and its extent and thickness recognized. If the two canals communicate above, and if there be but a single cervix, it is easy to feel it through each canal, which gives the impression that the cervix is double. C. Sauvage² summarizes the treatment of the septum under the following rules: Do not interfere during pregnancy, for fear of resulting cicatrization of the canal and risk of septic infection; interfere only exceptionally during the period of cervical dilatation; ligature and cut through the septum as soon as dilatation is complete, and the presenting part is forced against the obstruction. The treatment of the lateral haematocolpos, resulting from imperforation of one vaginal canal, will be dealt with under *atresia vaginae*.

Unilateral Vagina.—The rare cases of uterus unicornis are generally associated with a defective state of the vagina, for the latter is really only half a canal, being the product of the development of but one Müllerian duct. It is narrow, and placed rather too much to one side of the middle line. In the rare cases of pregnancy in a uterus unicornis the narrowness of the vagina will increase the difficulty and danger of the delivery.

Vagina Rudimentaria and Defectus Vaginae.—Vagina rudimentaria is a vague expression, and denotes, at best, a morbid state indistinguishable clinically from atresia vaginae and defectus vaginae. H. Küster,³ however, may be consulted on the anomaly. Complete absence of the vagina (defectus vaginae) also can hardly be determined during life, and is best considered under atresia vaginae (*q.v.*).

Atresia Vaginae.—In its morbid anatomy, vaginal atresia presents various degrees of imperforation and various associated anomalies of neighbouring parts. In its most marked form no trace of the canal is found save a fibrous or fibromuscular band in the tissue between the bladder and rectum; in a less extreme form, part of the vagina is present, whilst the remainder is solidly imperforate; and in a still less marked form, there is simply a membranous obstruction or perforated diaphragm at one part of the passage. The position, also, of the imperforation varies: it may exist throughout the whole length of the canal, or it may

¹ *Bull. Soc. d'Obst. de Paris*, xiv. 448, 1911.

² *Rev. prat. d'obst. et de pédiat.* xxiii. 129, 1910.

³ *Zeitschr. f. Geburtsh. u. Gynäk.* lxxvii. 692, 1910.

be present only at the upper part, or the middle part. With the knowledge of the development of the lower part of the vagina which is now possessed, it may be regarded as probable that atresia in that position is due to defective coalescence of the Wolffian bulbs with the urino-genital sinus. The uterus in cases of vaginal atresia may be normal, double, rudimentary, or absent; the ovaries and tubes are commonly healthy, at any rate at first; the vulva is generally normal, and possesses a hymen, but some instances have been reported of defective development of the pudenda; and in married women the small vestibular canal and even the urethra may be dilated as the result of attempts at coitus. At puberty the commencement of menstruation may lead to pathological changes. If the uterus be present in a more or less perfect form, and the whole vagina be absent, haematometra develops, and the whole uterus is converted into a large rounded sac, containing blood in various conditions of colour and consistence. In a few cases the cervical canal alone becomes distended with blood, as in Miles H. Phillips's case of haematotrachelos in a uterus bicornis unicollis, with absence of the vagina.¹ When the upper part of the vagina is present blood first accumulates in it, producing haematocolpos, and later haematometra follows; and when only the lower part of the canal is atresic, nothing more than haematocolpos may be the consequence, and the uterus may be found as a small body resting upon the apex of the distended vagina. On the other hand, blood retention may extend farther up in the genital system, and the Fallopian tubes become distended (haematosalpinx); even the ovary has been found the seat of a large blood-cyst (haematovarium), as in Abram Brothers' patient,² in whom the menstrual blood had been accumulating for four years. If the blood contained in any of these organs becomes infected from rupture, aspiration, or ineffective operation, pus may form, leading to pyocolpos, pyometra, pyosalpinx, and pyovarium. In a remarkable case reported by Chaput,³ there was haematometra of a uterus bicornis, along with torsion of the pedicle of the haematosalpinx, which coexisted therewith. Balfour Marshall⁴ has put on record a case of absence of the vagina, associated with displacement of the left kidney into the pelvis; ovaries were present, but the uterus was reduced to a rudimentary horn on the right side.

Clinical Features.—The clinical features of atresia vaginae will in part have been foreshadowed by the study of the morbid anatomy; they are in large measure the

¹ *Journ. Obstet. and Gynaec. Brit. Empire*, xiii. 355, 1908.

² *Contrib. Sc. Med. and Surg.* . . . 25th anniv. founding of New York Postgrad. Sch. and Hosp., pp. 294, 339, 1908; abstract in *Amer. Journ. Obst.* lvii. 572, 1908.

³ *Rev. de gynéc. et de chir. abd.* x. 963, 1906.

⁴ *Journ. Obst. and Gynaec. Brit. Empire*, xxiii. 238, 1913.

result of the accumulation of menstrual blood behind the imperforation, and they therefore do not appear as a rule till after the period of puberty is reached. Occasionally, however, in the young child the retention of mucus may cause a swelling which, by pressing upon the bladder and rectum, produces dysuria and constipation; but as a rule puberty marks the beginning of suffering. There is then amenorrhoea, or more correctly cryptomenorrhoea, and the gradual development of a swelling in the lower abdominal region, which may bulge also in the region of the vulva and perineum. In this swelling it is generally possible to make out fluctuation, but if the uterus is poorly developed or not developed at all, the tumour due to menstrual retention may be inconspicuous or absent. Soon severe pelvic pain, recurring periodically, is added to the cryptomenorrhoea, whilst bleeding from other parts of the body, such as the stomach and lungs (the so-called vicarious menstrual haemorrhage), has been reported. If the uterus be absent, these symptoms may not appear, and the beginning of suffering may then be postponed till marriage, when the dyspareunia, or complete inability to accomplish cohabitation, may be the source of much trouble and unhappiness, and may even lead to insanity. The imperfect coitus which is possible by elongation of the short vestibular canal or by dilatation of the urethra gives no real satisfaction, and, from the woman's point of view, increases distress. There is, of necessity, sterility; but it is noteworthy that operative treatment has occasionally been followed not only by establishment of menstruation but by the occurrence of one or more pregnancies and labours, (although Caesarean section has now and again been required to complete the delivery).

It is probable that most of the cases of atresia vaginae which are congenital are developmental defects; but the possibility that some of them have arisen during foetal life (or may arise later in infantile existence), from inflammatory conditions of an existing vagina leading to its obliteration, cannot be quite excluded. Of course the *acquired* atresias following upon severe labours are not considered here.

Diagnosis.—The diagnosis of this vaginal anomaly is not usually a matter of difficulty, although its extent and the degree of involvement of other organs may remain doubtful. When, in a young patient with amenorrhoea (cryptomenorrhoea) and monthly pelvic pain of increasing severity, an abdominal tumour, which fluctuates and gradually enlarges, is discovered, the presence of vaginal atresia may be suspected; and when, in addition, it is found on vaginal examination that the vagina is blocked either near its orifice or in its upper part, the diagnosis may be safely made. Further examination by means of rectal touch, aided by the presence of a sound in the bladder, abdominal palpation, and vaginal touch (when the lower part of the vagina

is patent), is chiefly undertaken to find out the extent of the atresia, the state of the uterus, and the condition of the ovaries and tubes, so that the proper treatment may be decided upon. There is, however, a part of the diagnosis which is extraordinarily difficult, viz. the separation of such cases as women with ovaries, a rudimentary uterus, and an atresic vagina from those of male pseudo-hermaphrodites with cryptorchidism. External appearances are no certain guide, and ovaries, especially if in an unusual position in the pelvis, can hardly be distinguished from undescended testicles, save by microscopical examination. The existence neither of *libido* nor of sexual apathy is a sure indication of the sex of the individual. Certainly, if grave doubt exist as to the real sex of the individual, the warrant for performing an operation for the creation of an artificial vagina, always somewhat precarious, ceases to exist. Opinions regarding the treatment of atresia vaginae have altered very considerably within the past fifteen years, and the introduction of a practicable and reasonably safe method (Baldwin's) of making an artificial vagina has greatly changed the view-point of the gynaecologist. Formerly, that is to say before the beginning of the twentieth century, atresia vaginae, accompanied by suffering but without the signs of haematometra, was generally treated by oöphorectomy; whilst if there was a rudimentary uterus or upper vagina containing retained menstrual blood, it was considered justifiable although difficult to try to reach the blood by a perineal incision, and to establish a fistulous tract by which, in future, menstruation might occur. Now oöphorectomy is out of favour, and the ethics of constructing an artificial vagina have changed, whilst few operators would try to reach a haematometra from the perineum alone, but would combine such a search with abdominal section.

Treatment.—It will be convenient, first, to describe the operative treatment of atresia vaginae, in which there is a uterus and a vaginal rudiment, and in which, therefore, interference is undoubtedly justifiable, and, second, the management of the cases in which no uterus exists, and in which consequently operation is undertaken solely for the more dubious purpose of providing a coitional vagina. Fuller details will be found in Balfour Marshall's admirable summary of operations and methods up to the end of the year 1912.¹

At first somewhat rude attempts were made to reach the haematometra or haematocolpos through the recto-vaginal septum by dissecting upwards with the knife, or boring upwards with the finger; and even these were safer than the still earlier plans of trying to tap the uterus through the rectum or bladder. Both procedures were accompanied in the hands, even of such expert surgeons as Dupuytren,

¹ *Journ. Obst. and Gynaec. Brit. Empire*, xxiii. 193-212, 1913.

Boyer, and Dubois, by a high mortality, due in all probability to sepsis. Now and again a success was reported, and even pregnancy followed in a few rare instances; but generally the canal rapidly contracted. In the last quarter of the nineteenth century a new plan was introduced by Heppner (1872), who, by implanting large tongue-shaped flaps of skin from the neighbouring thigh in the passage between the bladder and rectum which he had constructed, endeavoured to keep patent the artificial vaginal canal thus made. The same plan was followed, even when no haematometra existed, in order to give the woman a coitional vagina. Heppner was succeeded by many other operators who devised various methods to overcome difficulties or correct defects in his operation, some taking flaps from the external genitals, others using epithelial grafts, and yet others transplanting flaps of vaginal mucous membrane from other patients (suffering from prolapsus uteri and operated on by colporrhaphy). More recently A. H. Ferguson¹ and Dreyfus² have experimented along other lines with some slight success. Ferguson, for instance, worked up in the recto-vesical septum till he came to the peritoneum which he dissected off the bladder and rectum but did not open; then he took a U-shaped flap of skin from between the anus and urethra, and sutured it to the bladder which he had pulled well down, so that when the latter retracted it drew the flap up with it; similarly he attached two lateral skin flaps high up to the rectal wall which he had also pulled down, and the rectum by retracting drew them too up with it; and the cavity thus formed was kept distended with gauze. Ferguson reported two successes in three cases. Dreyfus's plan was still more novel: After opening up the recto-vesical septum and evacuating a haematometra with a trocar, he packed the cavity with gauze; two days later he transplanted the entire hernial sac removed from a man during operation for radical cure; the upper part of the transplanted sac gave way, but the lower united well and gave a good vagina. Other ways of utilizing peritoneum have been devised, but they all labour under the defect that the normal vaginal lining is not a serous but a mucous one.

Meanwhile A. Martin had begun (in 1880) to operate in another manner. He pointed out that distending the bladder was a better plan of keeping it out of the way in operation than passing a sound into it. He worked up in the recto-vesical septum with forceps, knife-handle, and finger till he reached the haematometra, which he perforated with the trocar; then he dilated the space and brought down the mucous membrane of the cervix and united it to that of the vulvar orifice. There were obviously great difficulties in the technique of this procedure, and it

¹ *Southern Medical Journal* (Nashville), iv. 210, 1911.

² *Bull. et mém. Soc. de Chir. de Paris*, n.s., xxxviii. 423, 1912.

gained little success till the vulvar mode of approach was supplemented by abdominal section. Even the combined operation (by the two routes) was full of difficulty—how full is demonstrated by such a case as that reported by W. Fordyce,¹ in which the abdomen had to be opened three times, after the vulvar route had been followed twice, before a satisfactory result was at length obtained. The combined abdomino-vaginal method, however, has been perfected by Pfannenstiel² and H. N. Vineberg,³ and is now generally regarded as the best operation in the cases in which there is a functioning uterus, especially if this be associated with a rudiment of the vagina. It is performed as follows: The first stage consists in opening up the recto-vesical septum as far as can be easily done; the patient is in the lithotomy position and the incision is made in front of the anus. Next she is placed flat in the dorsal position, and the abdomen is opened: the uterus is pulled up and incised so as to allow the retained blood to escape, the peritoneum is cut and stripped down with the bladder laying bare the cervix, and the cervical canal is next opened. Having thus freed the cervix the operator now passes a pair of catch-forceps upwards through the vulvar cavity which has been made and with this instrument bores through the remaining tissue of the septum, making the vulvar and abdominal cavities communicate. Strong sutures are next attached to the cervix, which is by them drawn into the vulvar canal, the uterine incision is closed, the peritoneum and bladder are replaced and fixed, and the abdomen closed. The final and most difficult stage is now reached: the patient is put again in the lithotomy position, the cervix is pulled down to the vulvar orifice by the sutures already referred to, and the newly-made cervical orifice is stitched to the mucous membrane of the vaginal rudiment, or in its absence to the skin of the vulvar cleft.

Various modifications have been made in Pfannenstiel's technique; but Vineberg's plan, adopted at a later date although independently of the German gynaecologist's work, is practically the same. Spontaneous labour has even followed a Pfannenstiel operation, but it is questionable whether in the event of pregnancy occurring, Caesarean section should not be performed as a matter of course on account of the risks the artificial vagina must necessarily run.

Most of the operative procedures which have been described may be employed for the purpose of making an artificial vagina even if there is no haematometra to be relieved, but they do not meet this particular indication so well as those now to be referred to in which the bowel is used to make the new canal. Gersuny⁴ implanted a resected flap from the anterior rectal wall in three cases with some

¹ *Trans. Edin. Obstet. Soc.* xxxvii. 224, 1912.

² *Beitr. z. Geburtsh. u. Gynäk., Festschrift . . . Fritsch., 1902.*

³ *Amer. Journ. Obstet.* liii. 511, 1906.

⁴ *Centrbl. f. Gynäk.* xxi. 404, 1897.

degree of success.¹ Küster² transplanted intestinal mucosa got from the resection of the bowel of another patient, and Sitsinsky³ tried to transplant from the intestine of a rabbit. But these plans could not be regarded as successful, and progress along this line was interrupted till Baldwin (*vide infra*) took up the matter, introducing ileum-transplantation and practically solving the problem of the provision of a satisfactory artificial vagina. Priority, in a sense, belongs to Sneguireff⁴ who, in 1904, recorded three cases in which he had transplanted the upper part of the rectum to form a sacral anus, and had used the lower part of the rectum to constitute the vagina. Since, however, the operation is not now performed it is unnecessary to give its details. Popoff⁵ devised a less objectionable operation: he resected the rectum just above the sphincter ani as well as higher up, pulled down the upper bowel and sutured it to the anal segment, and finally sutured the resected piece of rectum to the vulvar opening. In this way the normal anus was retained for defaecation and was not employed to form part of the ostium vaginae. Schubert⁶ modified Sneguireff's procedure still more radically, making two openings, one behind and the other in front of the anus, removing the coccyx, and keeping the perineal body intact; but since most gynaecologists prefer Baldwin's method there is no need to enter into a detailed description of Schubert's, although it must be regarded as having been successful in the hands of several operators.

In 1904 Baldwin⁷ showed the practicability of transplantation of a resected segment of ileum to form an artificial vagina upon the cadaver, and in 1907⁸ he reported a case in which he had operated successfully upon the living subject. It was, as a matter of fact, a case of acquired atresia vaginae, but that fact did not detract from the importance of the advance which had been made. The method is as follows: With the patient in the lithotomy position, the gynaecologist makes a transverse incision in the perineum at the site corresponding to the normal ostium vaginae. This incision is carefully deepened and carried upwards till the peritoneum is reached, but the serous membrane is not incised at this stage. A pair of catch forceps is placed in the wound, and some gauze is also introduced to keep the track open. The woman is now placed in the Trendelenberg position, and the abdomen is opened in the middle line. The field of operation is protected with gauze swabs, and the lower and most dependent part of the ileum is brought into the wound. A segment of the ileum, about 12 inches in length, is emptied of its contents, is resected by

¹ *Zentrbl. f. Gynäk.* xxix. 18, 1905; *Wien. med. Wchnschr.* liv. 485, 1904.

² *Centrbl. f. Gynäk.* xix. 809, 1895.

³ *Mon. f. Geb. u. Gynäk.* xii. 35-68, 1900.

⁴ *Zentrbl. f. Gynäk.* xxviii. 772, 1904.

⁵ *Russk. Vrach.* ix. 1512, 1910.

⁶ *Zentrbl. f. Gynäk.* xxxv. 1017, 1911; xxxvi. 198, 1109, 1912.

⁷ *Ann. Surg.* xl. 398-403, 1904.

⁸ *Amer. Journ. Obstet.* lvi. 636, 1907.

being doubly clamped at each end and cut, and the attached mesentery is carefully

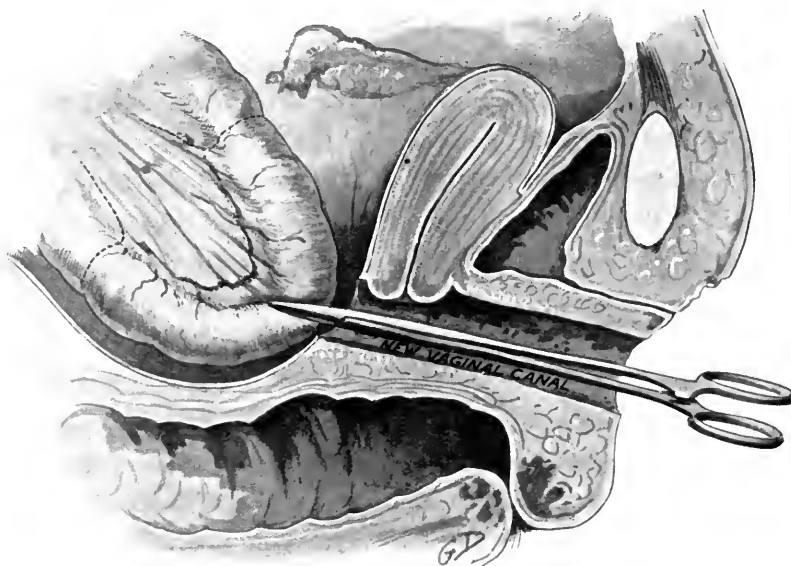


FIG. 132.—Baldwin's operation for atresia vaginae. (After H. J. Boldt.)

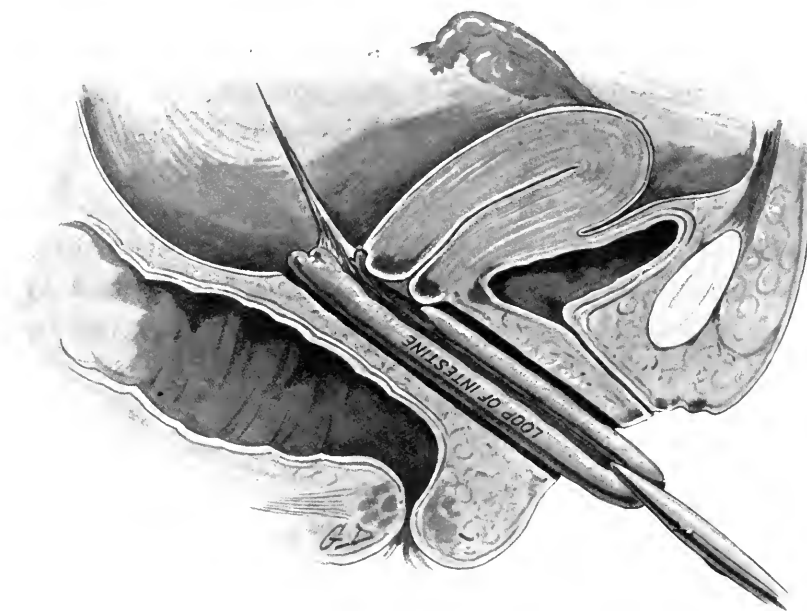


FIG. 133.—Baldwin's operation for atresia vaginae. (After H. J. Boldt.)

preserved. The ends of the resected part are inverted and closed with purse-string sutures, whilst the ends of the main bowel are connected by end-to-end anasto-

mosis, and the continuity of the intestine is thus restored. The mesentery is closed over the portion belonging to the resected segment. The next stage in the operation consists in opening the peritoneum, which covers the floor of the pelvis, and in pushing up the catch forceps which were left in the perineal incision from below. With the forceps the detached piece of ileum is caught at its middle or apex and is drawn down into the artificial vagina. The peritoneum covering the pelvic floor is now sutured, and the abdominal incision is closed. The woman is put back again in the lithotomy position. The resected portion of bowel is found lying in the artificial canal doubled up (*vide* Figs. 132, 133), and held in position by the catch forceps; it forms, as it were, a double vagina. It is opened at its centre, where it is grasped by the forceps, each leg of the loop is wiped out carefully, and packed with gauze so as to press it firmly against the walls of the artificial canal. The edges of the opening in the bowel are finally stitched to the edge of the perineal skin incision. A few weeks later the septum between the two halves of the artificial vaginal canal is divided so as to make one canal. Many operators, including H. J. Boldt,¹ have used Baldwin's method with success.

Some modifications of Baldwin's procedure deserve to be named. Abadie,² for instance, did not find it necessary to divide the septum in the artificially formed vagina, it retracted sufficiently by itself. W. Stöckel, too,³ did not divide the septum; he reunited the divided bowel by lateral not by end-to-end anastomosis (*vide* Fig. 134), and he pulled down the resected bowel by a silk suture and not by forceps. Mori,⁴ without knowledge of Baldwin's operation, used practically the same method, but he transplanted a single instead of a doubled-up loop of ileum. A considerable number of gynaecologists (Papanicol,⁵ Juvara,⁶ and others) have now performed Baldwin's operation or modifications of it, with a remarkable immunity from deaths, but, involving, as it does, bowel-resection, it cannot be regarded as absolutely safe; and there is the disadvantage that the vagina so constituted must not, of course, be douched with disinfectants. Any small rudiment of uterus which may be found during this operation should be removed, but the ovaries should be left.

The ethics of the formation of an artificial vagina have been discussed by many gynaecologists, and opinions differ within wide limits. Victor Bonney, who has also performed the operation with success, comes to certain conclusions which seem just and rational.⁷ It is not to be thought of in children before puberty.

¹ *Amer. Journ. Obst.* lxi. 428, 1914.

² *La Gynécologie*, v. 509, 1910; *Rev. de gynéc. et de chir. abdom.* xvi. 1, 1911.

³ *Zentrbl. f. Gynäk.* xxxvi. 7, 1912.

⁴ *Ibid.* xxxiii. 172, 1909.

⁵ *Ibid.* xxxvi. 1021, 1912.

⁶ *Rev. de gynéc. et de chir. abdom.* xviii. 463, 1912.

⁷ *Lancet*, ii. for 1913, p. 1059.

Unmarried girls whose only trouble is non-appearance of the menses should not be operated on, but their parents should be told of the possibility of interference

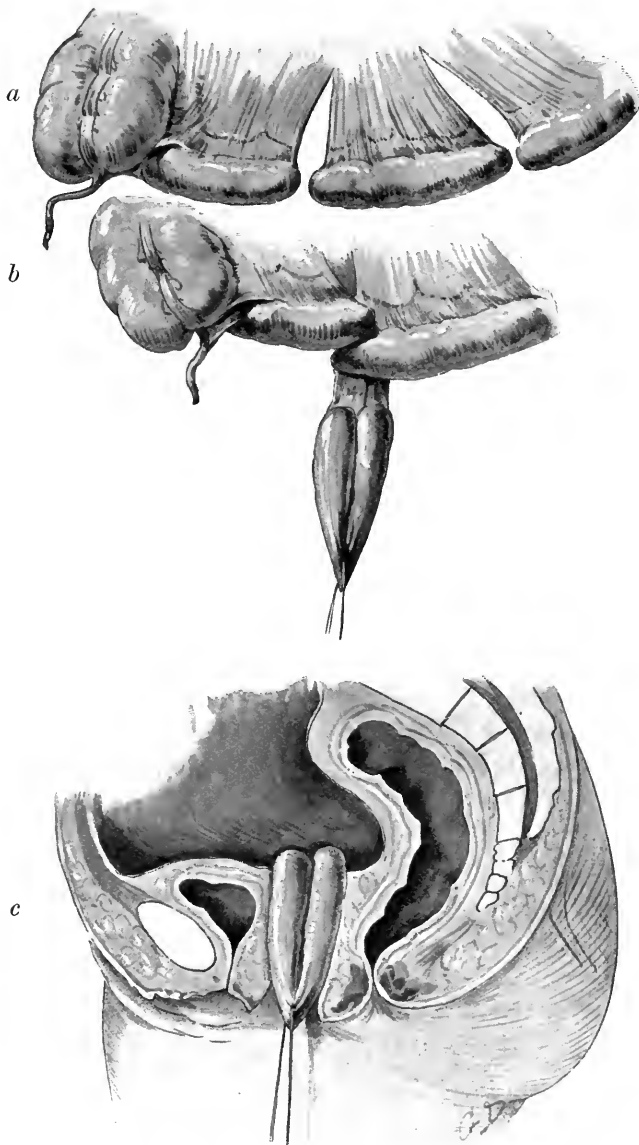


FIG. 134.—Operation for atresia vaginae. (After Stöckel.)

later and in certain circumstances. Unmarried girls, however, who are suffering from haematometra may require operation but not necessarily Baldwin's; the proper procedure may be removal of the rudimentary and distended uterus. The case of unmarried girls who are contemplating matrimony is difficult. The wishes, sex-feelings, and character of the girl herself, her parents' wishes, and the desires of her *fiancé* after matters have been fully explained to him by the gynaecologist, must all be taken into account; if all concerned are in favour of operation, Bonney thinks it should be performed. It is also justifiable when the deformity is producing mental symptoms threatening sanity. In the case of married women in whom the sex-sense is active, to whom the meaning of the operation has been made fully known, and by whom, as well as by their husbands, such operative treatment is urgently desired, Baldwin's operation or some similar procedure may be carried out. Married women, however, with no sex-sense, who simply are willing to be operated upon in order to gratify their husbands' desires, however strongly expressed, should as a rule be refused. To sum up: When there is no probability that conception will follow, the con-

operation may be carried out. Married women, however, with no sex-sense, who simply are willing to be operated upon in order to gratify their husbands' desires, however strongly expressed, should as a rule be refused. To sum up: When there is no probability that conception will follow, the con-

struction of a purely coitional vagina is a procedure which ought never to be lightly embarked upon.

Atresia Vaginae Lateralis.—When one of the two halves of a double vagina is imperforate, either at its lower end or in its middle portion, there is produced the anomaly known as atresia vaginae lateralis; and when the cavity thus formed communicates with a functioning uterus or semi-uterus above, it is gradually distended with menstrual blood, giving rise to lateral haematocolpos of the inferior or superior type. The infection of the contents of the sac leads to the production of pyocolpos lateralis, and with it pyometra and pyosalpinx may come to be conjoined. The right side is much more frequently the site of atresia than the left. Recently Vautrin¹ has described a rare form of lateral haematocolpos, in which the sac was divided into two cavities lying one above the other and separated not by a partition but by a perforated diaphragm.

Clinical features usually begin to appear at puberty, but they may be absent altogether, and the anomaly not even suspected during life. Generally the accumulation of menstrual blood causes vaginal pain, either at the time when menstruation is in progress (dysmenorrhoea) or a little later when the fluid in the sac has come to be under high tension; the pain tends to die away in the intermenstrual interval, reappearing at the next period. With this pain there may be associated pressure symptoms of various kinds (dysuria, painful defaecation, etc.), and when the blood accumulation is large an abdominal swelling may become evident. A vaginal examination reveals an elastic, tense tumour at one side of the patent canal, bulging into it, and having a consistence varying with the state of its contents. It must be distinguished from vaginal fibroids (rare), from congenital vaginal cysts (derived from the Wolffian body or from Gartner's duct), from hydatid cysts (very rare), and from pelvic haematocele. Since it may rupture, become infected, and the infection spread upward, the prognosis of atresia vaginae lateralis is not good; in fact it must be considered as a dangerous affection. Treatment, accordingly, must be well chosen and active. Puncture or incision of the sac should only be regarded as diagnostic means, and for curative purposes their place should be taken by excision of the intervaginal septum which shuts off the atresic cavity from the well-formed vagina; the operation may involve difficulties, but none greater than the ingenuity of the surgeon can overcome. When the sac has become infected, or when there is a risk of ascending infection, Vautrin (*loc. cit.*) counsels double (not single) oöphorectomy; double salpingectomy, whilst conserving the ovaries and their internal secretion, is not so certain in its curative effect. Hysterectomy, however, may be

¹ *Ann. de gynec. et d'obstet.* 2nd s. ix. 449-485, 1912.

demanded when the uterus is the site of pyometra, but if only one-half of a uterus didelphys is involved then the proper operation is hemi-hysterectomy, which may be total or sub-total but preferably the former.

Stenosis Vaginae.—Abnormal narrowness of the vaginal canal calls for no separate description. Most commonly it is the result of atresia vaginae lateralis, or is the concomitant malformation of a uterus unicornis. In a few cases stretching of the canal may be necessary in face of the danger of laceration during labour, and it is conceivable that Caesarean section may be called for in certain circumstances, as indeed it has been needed in acquired stenosis of cicatricial origin.

ANOMALIES OF FORMATION OF THE VULVA

Under the above heading it is convenient to describe certain malformations of the vulva, the cloaca, and the individual parts of the pudenda, and to reserve some others for discussion under the title of hermaphroditism (or pseudo-hermaphroditism).

Double Vulva.—Apart from the cases of united female twins in which there are two pelves and consequently two vulvae, double vulva has in very rare instances been recorded in individuals otherwise single in the anatomical sense. There was the case of Katharine Kaufmann (reported by Suppiger) to which reference has already been made (p. 257), and there was another instance (in a young child) described by Chiarleoni.¹ Within recent years J. E. Gemmell and A. M. Paterson² have put on record a case of double vulva in an adult woman, whose extraordinary experience it was to give birth to a child through each vulvar aperture. She had two uteri, two vaginae, two urethrae, and two bladders, as well as an incomplete duplication of the lower end of the vertebral column. The two vulvae were complete in their parts but were not quite symmetrical (*vide* Fig. 129).

Defectus Vulvae, Atresia Vulvae, etc.—Complete absence of the vulva is an anomaly which occurs only in monstrous foetuses of the acephalic or sympodial type; generally the anus is also wanting. Under the skin, which sweeps, unbroken by any irregularities, from the symphysis pubis to the coccyx, there may be found the bladder, rectum, and genital ducts all opening into one cavity (persistence of the cloaca), or the bladder and genital ducts may be discovered with a common termination (persistence of sinus urogenitalis), the rectum having been shut off by the development of the recto-vaginal septum. In such cases the foetus at birth may show abdominal distension due to accumulation of urine in the cloaca or sinus.

¹ *Ann. di ostet. e ginec.* xvi. 469, 1894.

² *Journ. Obst. and Gyn. Brit. Empire*, xxiii. 25, 1913.

Atresia vulvae superficialis presents to a cursory glance the same features as defectus vulvae; but on closer examination it is found that the apparent absence of the vulvar cleft is due to adhesion of the labia (perhaps from ante-natal vulvitis), and that there is one spot at which the adhesion is incomplete, leaving an exit for the urine at first and for the menstrual blood at a later age. There may, however, be difficulty both with micturition and, later, with menstruation (cryptomenorrhoea); at marriage also it may be necessary for the gynaecologist to break down the adhesions before coitus can be practised, although, curiously enough, conception has been known to occur, the seminal fluid being able to make its way in through the small aperture. A probe or director is passed in through the opening which is generally anterior (at the root of the clitoris), and then dissection down to it is carried out, laying bare the vaginal orifice. The anomaly known as *vulva infantilis* is simply the persistence in the adult of the type and characters of the vulva as it is seen in the young infant, and it is commonly associated with defects or malformations of the internal genital organs and with the systemic disorder known as chlorosis.

Persistence of Cloaca.—The most marked instances of persistence of the cloaca are found in monstrous foetuses, such as the exomphalic and acephalic, and have consequently no clinical importance. Their mode of development, too, belongs more to pathology and to teratology than to gynaecology. It may be stated here, however, that to a gynaecologist, D. Berry Hart of Edinburgh, the profession is indebted for several illuminating papers¹ on the development of the cloaca (entodermal and ectodermal), of the hymen, of the lower end of the vagina, and of the various malformations to which these parts are subject. Certainly there is a simplification of the origin of the cloacal and vulvar defects if one believes with Hart that only the upper two-thirds of the vagina are derived from the Müllerian ducts; that the lower third is due to the coalescence of the upper portion of the urino-genital sinus and the lower ends of the Wolffian ducts; that the epithelial lining of the vagina is derived from the Wolffian bulbs which, in their turn, are epithelial proliferations of the lower ends of the Wolffian ducts; and that the hymen forms at the opening of the Wolffian ducts and not at the eminence of Müller. Further light will be thrown on a dark subject if Hart's suggestion turns out to be correct, and it be shown that the Wolffian bulbs block the urino-genital sinus, and that the lumen is re-established as a double one, urethral and vaginal, by an epithelial central resolution and by involutions from the sinus below. In the light of this hypothesis, for instance, it is much easier to understand the origin of the malformation now to be described, viz. vulvar anus.

¹ *Trans. Edin. Obstet. Soc.* xxi. 106, 1896; xxii. 18, 1897; xxvi. 259, 305, 1901; xxxvi. 160, 1911.

Atresia ani vaginalis or **Anus vulvalis s. vaginalis**.—In the cases to which the above names have been given the normal anus is absent, and the rectum apparently opens into the vagina or the vulva but really into the urino-genital sinus. In most instances the opening of the bowel is just behind the hymen (*vide* Fig. 135), and in

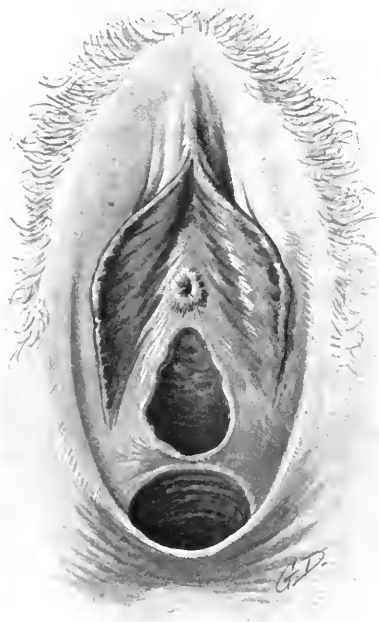


FIG. 135.—Anus vulvalis. (After Dwight.)

front of the posterior commissure of the vulva (in the fossa navicularis), but it may be farther forward or deeper. The chief symptom, and it is a distressing one, is the passage of the faeces through the abnormal opening, for it keeps the external genitals constantly moist and sore, and, since there is often no sphincter, the involuntary nature of the act of defaecation intensifies the patient's suffering, and she gets into the habit of producing artificial constipation by the help of morphia or other binding drugs. Sometimes there is grave dyspareunia, and this, combined with the discomfort of the involuntary motions, may lead to despondency and even to mental disease. In such cases operation must not be delayed. Various modes of operating have been described; but the best is probably the following. An incision is made round the abnormal anal opening, and extended through the posterior vaginal wall and the perineal body to a point just below where the anus should be. The rectum, next, is dissected free from its attachments, and, with the anus, is placed within the bed formed for it by the incision just described; its lower end is then sutured to the skin in the place which the anus normally occupies, and the posterior vaginal wall and the perineum are sutured together in front of it. If the bowel is provided with an external sphincter the operation is easier and the result more satisfactory, but if it is not so provided the search for the external sphincter is often fruitless, although it should be attempted. Some operators make the new anus in two stages, splitting the fibres of the levator ani muscle in order to secure a good sphincteric action.

Hypospadias in Woman.—Just as atresia ani vaginalis is a sort of persistence of the cloaca, so the malformation known as hypospadias is in a sense a persistence of the sinus urino-genitalis. It is a very rare anomaly in the female. The perineum

is normally formed, and the rectum opens in the usual way at a naturally placed anus; but the vestibular canal is long and narrow, and receives the opening of the urethra and the vagina fairly high up, or, in more marked cases, the urethra is quite absent, and the vagina and bladder both open together into the vestibular canal, giving an appearance as if the bladder opened directly into the vagina. The chief clinical feature is incontinence of urine; but, since the absence of the posterior urethral wall may be associated with enlargement of the clitoris, some doubt as to the real sex of the individual may arise.

Epispadias in Woman.—Epispadias, in contrast to hypospadias, consists in a defect of the upper or anterior wall of the urethra. It is very rare in the female in comparison with the male. The anomaly may occur alone, when the urethra is seen as an open groove passing upwards in the region of the vestibule, and disappearing under the symphysis pubis to end directly either in the bladder or in the upper and closed part of the urethra; usually one-half of the split clitoris can be seen on each side. Some writers have subdivided female epispadias into three varieties—clitoridian, subsymphysary, and retrosymphysary—according as a smaller or larger part or the whole of the anterior urethral wall is wanting. More commonly epispadias is associated with ectopia vesicae and separation of the symphysis pubis;¹ then the two halves of the clitoris are widely distant from each other, as are also the labia minora and majora, and the vulvar cleft is continuous with the exposed mucous membrane of the cleft urethra and bladder, on the surface of which, in the vesical area, can be seen the openings of the ureters. This malformation is probably due to a giving way of the cloacal membrane which forms the anterior boundary of the entodermal cloaca (Berry Hart).

In all cases save the slightest degrees of epispadias incontinence of urine is a leading symptom. When the bladder is closed in anteriorly the incontinence may be incomplete, but generally it is constant and so troublesome as to make the girl's life a misery. The other symptoms, such as excoriation of the skin of the thighs and occasional infection of the kidneys, are to be ascribed to the incontinence. For the relief of the urinary inability various operations have been attempted, such as narrowing the calibre of the urethra and lengthening the canal; then, by a plastic operation the separated vulvar structures can be freshened, drawn together, and sutured in the middle line. But in the grave degrees the gynaeccologist may be driven to transplant the ureters into the rectum or undertake some extensive reparative procedure. It may be added that epispadias in the female does not interfere with menstruation, and has even been accompanied by pregnancy.

¹ Ballantyne, *Edin. Hosp. Rep.* iv. 247, 1896.

Anomalies of the Clitoris and Labia, Hyposynclisis.—The clitoris may be found in a split or bifid state, as in epispadias and ectopia vesicae, or, rarely, as a solitary anomaly. Congenital hypertrophy of the clitoris may be met with, but this change cannot always be separated from the acquired form. When to a degree of clitoridian hypertrophy there is superadded a union or adhesion of the labia, a condition closely simulating the male penile urethra and scrotum is produced, and may lead to mistakes in sex. To this imitation of the appearances of the masculine external genitals Arthur Keith¹ has given the name of hyposynclisis. It has sometimes been said that so far as the external genitals are concerned a woman is a hypospadiac male; so, now, the comparison may be turned the other way, and it may be said that so far as the external genitals are concerned a man is a hyposynclisic woman. If the ovaries come to lie in the labia in such a case the resemblance to the male type becomes very striking. Hypertrophy of the labia minora may also occur as a congenital malformation, and the “Hottentot apron,” as it has been called, is a racial anomaly of this nature. The clinical importance of these clitoridian and labial deformities chiefly shows itself in connection with cases of pseudo-hermaphroditism. Possibly the hypertrophy of the parts may be the cause of local irritation leading to masturbation and nervous phenomena; but possibly, also, it may be the effect, unless of course the overgrowth was recognized at birth.

Anomalies of Formation of the Hymen.—If, as Berry Hart maintains (*loc. cit. supra*), the hymen is formed by a special bulbous development of the lower ends of the two Wolffian ducts, aided by an involution from below of the cells lining the urino-genital sinus, then the various anomalous forms which the membrane may assume are made easier of explanation. Thus, the double hymen, as it has been called, could be regarded as due to a persistence of the upper as well as of the lower edge of the Wolffian bulbs, a condition which indeed is found at a certain stage of development. In most cases, however, the second (internal) hymen is generally to be looked upon as a diaphragm due to imperfect disappearance of the lower end of the Müllerian vaginal septum. Other variations in the hymen are found in the labiated form in which there are two projecting lips or margins (normal in the infant), in the notched form (*hymen denticulatus*), and in the fimbriated (*hymen fimbriatus*). If the aperture be central the *hymen circularis* is produced, if there be two orifices of equal size, situated laterally, the *hymen septus* results, whilst if the openings be two or more in number and situated irregularly the varieties known as *hymen biforis* and *hymen cribriformis* are formed. The *hymen falciformis* has a very large opening in it. In structure, too, the hymen may show irregularities. It may be

¹ *Brit. Med. Journ.* ii. for 1908, p. 1858.



Imperforate hymen. (Eden and Lockyer.)

abnormally rigid, or thick, or vascular, and these structural anomalies may give rise to trouble in coitus, the unusually thick or rigid membrane causing dyspareunia or actual impossibility of penetration, and the vascular hymen producing dangerous haemorrhage at the time of the first sexual congress. The treatment in the former case is excision of the membrane; in the latter the bleeding points may call for ligature after the hymeneal fragments have been cut off; the bases of them have to be stitched. Vaginismus, also, is occasionally due to some structural irregularity in the hymen, which may necessitate surgical interference (excision followed by stretching).

One other anomaly of the hymen calls for mention, *atresia*. The older literature is full of cases of imperforate hymen (*atresia hymenalis*), but the newer is more discriminating, and tries to separate atresia of the lower part of the vagina from persistence of the hymeneal membrane proper; and there can be no doubt that many cases which were classed as the latter were really instances of the former. In the true examples of imperforate hymen the clinical features are the projection from between the labia at puberty of a bluish membrane (see Plate V.), along with pain often of a colicky and sometimes of an agonizing kind, worst at periods of a month, and accompanied by rectal and vesical trouble and occasionally by xenomenia or so-called vicarious menstruation. The symptoms, of course, are due to haematocolpos; and in advanced cases haematometra, leading to the formation of an abdominal tumour, and haematosalpinx may follow.

ATYPICAL SEX CONDITIONS OR PSEUDO-HERMAPHRODITISM

There is good reason for agreeing with Berry Hart¹ in his conclusion that the terms hermaphroditism and pseudo-hermaphroditism as applied to the human subject are inadmissible. They have certainly been long in use; but he contends that true hermaphroditism, whether anatomical or functional, has never been shown to exist in the mammalia, and since it is incorrect to speak of a spurious form of a non-existent thing, it is well to cease using them altogether. Of course, mammalian hermaphroditism is theoretically possible, or at any rate there is no known reason why it should not occur. Further, if, in any of the cases of so-called ovo-testis which have been recorded,² the testicle can be shown to be really the male gland, and not a deformed ovary or part of an ovary, then the possibility of anatomical hermaphroditism must be conceded; but it cannot be claimed on sufficient evidence

¹ *Edinburgh Med. Journ.*, n.s. xiii. 12, 101, 295, 1914; xiv. 410, 1915.

² E.g. in Blacker and Lawrence, *Trans. Obst. Soc. Lond.* xxxviii. 265, 1896; and Blair Bell in *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, vol. viii. p. 77.

that this has yet been done. It is unnecessary, therefore, to consider in detail Klebs's three varieties of true hermaphroditism, but they may be named simply. There is the *bilateral* or vertical variety, in which an ovary and a testicle are found on both sides of the body; the *unilateral*, in which there are an ovary and a testicle on one side, and an ovary, or a testicle, or neither on the other side; and there is the *lateral* or *alternate* variety, in which there is an ovary on one side and a testicle on the other. Hart (*loc. cit. supra*) suggests instead of pseudo-hermaphroditism the term *atypical sex-ensemble*, meaning thereby not that the sex is atypical but that all the structures and characters and functions which go to make up the sexual life of the individual are not combined together in the normal or typical way, whether that way be the male or the female. It is to be noted that so long as there are ovaries or testes, containing ova in the one case and spermatozoa in the other case, there is no question of atypical sex, even if the sex-gland be smaller than normal or otherwise altered; the only possible case of atypical sex is that in which the apparent sexual gland (female or male) is not found to contain ova or spermatozoa. The presence, therefore, of the sexual gland decides the sex of the individual, but that individual may be atypical in his or her sex-ensemble, *i.e.* in the whole of his or her structures, functions, and psychical outlook which go to make up maleness or femaleness. Hart, therefore, at once gets two large subdivisions—the atypical female sex-ensemble (Figs. 138 and 141) and the atypical male sex-ensemble (Figs. 137, 139, and 140), the latter being much the larger group of the two. The former condition corresponds to gynandry or *pseudo-hermaphroditismus femininus*, and the latter to androgyny or *pseudo-hermaphroditismus masculinus* of the older classifications.

The whole subject comes into close and frequent but not into exclusive relationship with gynaecology. The gynaecologist, in his consulting-room or in the operating-theatre, may make the discovery that the person he is seeing clinically or treating surgically is not a woman, as has been supposed, but a deformed male; he may find, in other words, that he is dealing with a case of atypical male sex-ensemble and not with one of normal (typical) female sex-ensemble. Thus he may recognize that the apparent woman is a hypospadiac man with a testicle in one half of a split scrotum, and he may make reasonably sure by feeling the spermatic cord against the ramus of the pubes; or, when he has opened the abdomen of a reputed female, he may find testicles either without or with a uterus, and be driven to the conclusion that the sex of the person is really male. But the matter is not a purely gynaecological one; the general surgeon, operating upon a hernia in a patient with all the external characters of a man (as in Somerton Clark's case¹), may find a uterus and tubes;

¹ *Journ. Obstet. and Gynaec. Brit. Empire*, xxv. 91, 1914.

the alienist may be called upon to deal with the cases of melancholia and suicidal mania which are associated sometimes with anomalies of formation in the reproductive organs; and even the throat specialist (as in E. Berthold's experience¹) may, from the appearance of the vocal chords, be led to suspect that the individual he is examining laryngoscopically is not of the sex which is apparent. In this work it is chiefly to atypical sex-ensemble in its gynaccological bearing that the attention of the reader is directed.

With regard to the external generative organs, which are so much relied upon (at any rate at birth) to settle the sex of the individual, it must be borne in mind that a comparatively small malformation has the effect of making these parts in the one sex show an extraordinary resemblance to the parts of the opposite sex. Thus in the male, hypospadias, which is simply a want of union of the parts forming the floor of the penile urethra and a lack of fusion of the two halves of the scrotum, immediately gives to the external genital organs a striking resemblance to the female pudenda (*vide* Fig. 136), a resemblance so marked that the individual as an infant will probably be registered as a girl. On the other hand, in the female child it only needs hyposyneclisis, or the union of the labia



FIG. 136.—Male hypospadias with non-union of the lateral halves of the scrotum.

minora under the clitoris so as to form a clitoridian urethra, along with a certain degree of hypertrophy of the clitoris itself, to give the external appearances of the male. If, in the former case, the hypospadias is associated with the presence of a urino-genital sinus, and if the testicles are retained in the abdomen, and if, in the latter case, the ovaries have descended into the labia, nothing short of a histological examination of the genital glands will enable the observer with certainty to determine the proper sex of the individual. So far, therefore, as the external genitals enter into the composition of the sex-ensemble they are little to be

¹ *Arch. f. Laryngol. u. Rhinol.* ix. 70, 1899.

trusted to for settling the sex; in fact the normal female may be regarded as a hypospadiac male and the normal male as a hyposynelesic female *qua* the external sexual organs. Typically the male has a descended sexual gland, a vas deferens, a fully-represented phallus, with the scrotum forming one structure; whilst typically the female has an undescended sexual gland, a phallus reduced to the incomplete clitoris, and the parts ununited in the middle line.

With regard, in the next place, to the secondary sexual characters, it may at



FIG. 137.—External genitals in Tuffier and Lapointe's case of atypical male sex-ensemble. There is no external aperture except the urethral one, and the testes are in the split scrotum. Psycho-sexual feeling for male.

once be stated that they also are no sure guide to the real sex in atypical cases. The part they take in the formation of the sex-ensemble is, however, of great importance from the standpoint of the status of the individual in the eyes of the public. In the normal female, the pelvis is capacious and lighter than in the male, the hips are wider apart, the hair distribution on the body (especially on the abdomen) is characteristic of the female, the larynx has slighter vocal chords, and the thyroid cartilages are less ossified, the bones and muscles are less strong and powerful, the psycho-sexual feeling is normally for the male, and emotion enters more into the mental sphere, and self-sacrifice is more developed, especially in connection

with child-bearing. In the normal male, the pelvis is less capacious and heavier, the hips are closer together, the hair areas are characteristically male in their arrangement, the larynx has stronger vocal chords and more ossified thyroid cartilages, the bones and muscles are more massive and powerful, the psycho-sexual feeling is normally for the female, the mental condition shows more activity, originality, artistic and literary power, and less emotion, along with a greater expression of selfishness (egotism). When one turns now to atypical sex-ensemble, one finds the most varied interchange of these secondary sex characters; one, two, or more (even all) of the male characters being found in an individual with ovaries, and (more often) one, two, or more (even all) the female characters being discovered in an individual with testicles. Even menstruation, which occupies a somewhat peculiar relation to sex, is no exception, for whilst the atypical female sex-ensemble does not usually exhibit menstruation, the atypical male sex-ensemble may sometimes show a sort of spurious menstruation. It may be added that the mammary glands are

no criterion, for in atypical male sex-ensemble there is often gynaecomastia, and in atypical female sex-ensemble there may be non-development of the breasts. At first thought one is tempted to rely upon the psycho-sexual feeling for the opposite sex, concluding that if the individual is attracted by women he must be a man, and if by men she must be a woman; this is not a fixed rule, indeed the atypical individual may have a psycho-sexual feeling for persons of the same or of the opposite sex (as determined by the sex glands present), for neither, or, more remarkable still, for both.

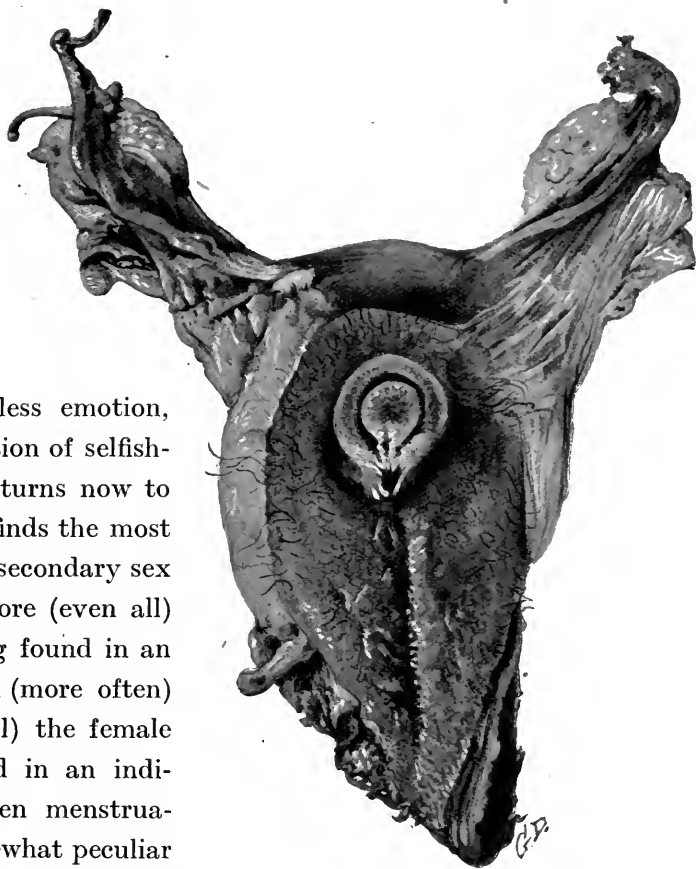


FIG. 138.—Atypical female sex-ensemble (female pseudo-hermaphroditism). Anterior view of genitals in Tibiger's Case 2. Note the apparent male hypospadias. The fundus uteri, tubes, and ovaries are seen above the pubes. A prostate was present, and the vagina opened into the prostatic sinus. The individual acted as husband.

With regard, now, to the internal organs, a very difficult and curious state of affairs is found both in typical and in atypical sex-ensemble. Normally, the internal reproductive organs contain not only the parts peculiar to the sex to which the individual belongs (as determined by the presence of ovaries or testicles), but also *in petto* or *in retentis* (so to say), the parts which are peculiar to the sex to which the individual does not belong, with the single but all-important exception of the sexual glands themselves. In other words each sex contains the typical



FIG. 139.—External genitals from case of atypical male sex-ensemble (male pseudo-hermaphroditism) published by Martin of Birmingham. Anus, fourchette, hymen, labia majora and minora, vestibule are seen. The testes were in the demi-serotum. The individual had acted as wife.

internal reproductive organs of the opposite sex in an abortive or at least incompletely revealed form, but never the genital glands of the opposite sex, in addition to its own. On this subject also Berry Hart (*loc. cit.*) has thrown a flood of light. He has pointed out that in the normal female sex-ensemble there are first the ovaries, uterus, tubes, and vagina; and second, as representing the opposite sex duct-elements, the epoöphoron (parovarium) with its duct, and the paroöphoronic tubules. The former are in a state of potency whilst the latter are atrophic; when the former are at their maximum and the latter at their minimum of development the normal

sex-ensemble for the female is produced. In the normal male sex-ensemble there are first the testicles, the vasa deferentia, the vesiculæ seminales, and the prostate; and second, as representing the opposite sex duct-elements, the hydatid testis, and the prostatic utricle. On the other hand, in atypical sex-ensemble, the so-called pseudo-hermaphroditism, the genital glands of the one sex are present along with duct-elements of the opposite sex in varying amount, but never in the maximum and minimum relation which is seen in normal sex-ensemble. Thus one may meet with uterus and Fallopian tubes (Müllerian duct-elements) in

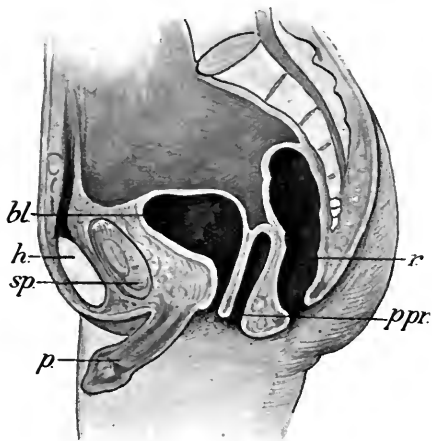


FIG. 140.—Leopold's case of atypical male sex-ensemble, in diagrammatic mesial section.
p, Phallus; sp, symphysis pubis; h, testes; bl, bladder; r, rectum; p.pr, urino-genital sinus.

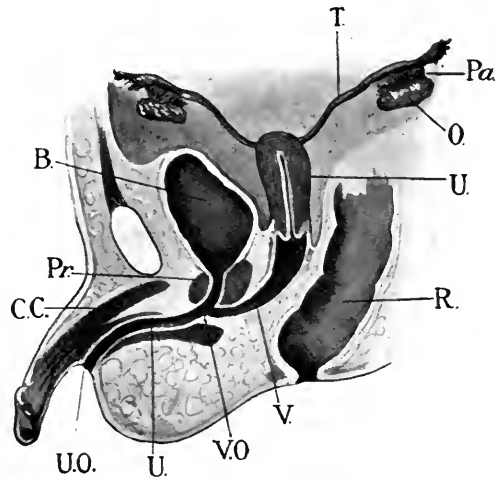


FIG. 141.—Diagrammatic sagittal mesial section of atypical female sex-ensemble (female pseudo-hermaphrodite). Note the vagina ending in the prostatic sinus, the prostate, and the simulated hypospadias. (Tibiger.)

T, Fallopian tube.	U, Urethra.
Pa, Parovarium.	B, Bladder.
Pr, Prostate.	U.O, Urethral orifice.
U, Uterus.	V.O, Vaginal orifice.
R, Rectum.	O, Ovary.
V, Vagina.	C.C, Corpus cavernosum.

an individual with testicles, and with a prostate in an individual with ovaries. The varieties thus produced are very numerous, and when they are combined with the varieties which exist in the external genital organs, in the psycho-sexual feeling, and in the secondary sexual characters, a very long list of atypical sex-ensembles is revealed. So many are they that it is impossible to do more in a work such as this than indicate two or three of the most commonly-met combinations of anomalous conditions (*vide antea*), leaving the reader to explore such a large work as that on *Hermaphroditismus beim Menschen*, published by Franz Ludwig von Neugebauer in 1908, for further information regarding individual cases.

A fresh complication has been of late introduced into the subject of sex-anomalies

by the work of Blair Bell,¹ Glynn² and others, who have shown that the ductless glands or endocrinous organs in the body, and especially the suprarenal bodies, have a curious relationship with the purely sexual glands. It is difficult to foresee to what ultimate conclusions this expansion of the prevailing notions of sex may lead; in the meantime it complicates and to some extent confuses the issue. If a woman is a woman not simply because of her ovaries but because of the action and interaction of all her endocrinous organs, then new possibilities, in regard more especially to the secondary sexual characters of the opposite sex which she may show, are introduced into the clinical picture which she may exhibit; similarly if a man is a man because of the interaction of his ductless glands and his testicles his maleness must be looked upon as a much more complicated ensemble than it has been hitherto. As Blair Bell (*loc. cit*) puts it, "*propter secretiones internas totas mulier est quod est,*" and it is this that makes a difficult subject so much more complicated.³

The practical bearing of the subject is revealed at birth when the obstetrician may be in doubt as to the sex of the child; if it be difficult to determine whether the child is boy or girl it should be brought up as a boy, for the chances in atypical sex-ensemble are ten to one that it is male (*i.e.* has testicles), and, further, a girl brought up among boys will not introduce the same risks as a boy brought up among girls. The question of atypical sex-ensemble again assumes importance at puberty, when the gynaecologist may be asked to diagnose and treat a case of delayed *menarché*; he may find he has to do with a hypospadiac male with testicles undescended or descended, with a vestibular vagina, and with various secondary sexual characters of the female, and with perhaps some of the opposite sex duct-elements (*e.g.* uterus and tubes). Then a difficult problem arises. Should the individual be removed from among the women and placed with the men of the population? It is true that redeclaration of sex, and the starting of the individual on a new life, have been carried through in some cases, and with some degree of success, as in Sir Halliday Croom's case of hypospadiac brothers;⁴ but the process is fraught with difficulties, not the least of which is the individual's reluctance to change her or his sexual status. At marriage new problems emerge.

In the case of a hypospadiac male married as a woman to a man, what advice is the obstetrician or gynaecologist to give? Of course, if it is clear by the clinical demonstration of the presence of testicles and spermatic cords, and still more by the

¹ *Lancet*, i. for 1913, pp. 809 and 937; *Brit. Med. Journ.* ii. for 1913, p. 1274.

² *Quart. Journ. Med.* v. 157-192, 1912.

³ This matter is more fully dealt with in the Articles on Physiology (p. 91) and Disorders of Function (p. 288).—EDITORS.

⁴ *Trans. Edin. Obstet. Soc.* xxiv. 102, 1899.

histological examination of a piece of the genital gland (removed by operation), that the supposed wife is really a deformed male, then the legality of the marriage can no longer be maintained. But if, on the other hand, it is not possible to tell with accuracy what the sexual glands are, then it has been proposed to do certain minor operations, and perhaps a major one, to fit the individual of doubtful sex for the rôle he or she has been called upon by marriage to play. If, for instance, the clitoris is hypertrophied, it has been suggested that it should be amputated; but it is doubtful whether this plan should be followed so long as there is a chance that the apparent clitoris is really a penis. For the same reason attempts to dilate the vestibular vagina to facilitate coitus, and to make an artificial vagina by intestinal transplantation are to be refused if there be the slightest probability that the individual is a deformed male with testes either descended or undescended. It is also extremely dubious whether the testicles which have descended into the split scrotum of a hypospadiac male should be removed surgically either before or after marriage as a woman. It would almost seem, in the present state of our knowledge of these perplexing, and greatly to be pitied cases of persons of atypical sex-ensemble, that the safest plan is to do nothing. At the same time one cannot shut one's eyes to the misery which is entailed in some cases, and to the record of insanity, of suicide, and of crime, which is associated with the existence of deformities which cause doubt as to sex.

DISORDERS OF FUNCTION

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PART I

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DISORDERS OF FUNCTION

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- (1) Physical anomalies.
 - (a) Apareunia.
 - (b) Dyspareunia.
- (2) Psychical derangements.
 - (a) Deficient sexuality.
 - (b) Limitation of sexuality.
 - (c) Excessive sexuality.

SECTION II

Derangements of Conception.

Sterility : absence of fertilization and implantation.

INTRODUCTION

Health with beauty, happiness and charm—the most desirable attributes of Woman—are largely dependent on the normal condition of the specialized functions: full possession of feminine characteristics, physical and psychical, normal menstruation, conception, parturition and lactation all contribute to final result—perfect womanhood.

In the following articles we shall be concerned only with those deviations from the normal which are connected with menstruation, fertilization and the sex characteristics. Reference to the normal processes will occasionally be necessary to make clear the cause of abnormal conditions; for it is only during the last decade that the physiology of the genital functions in the female has received adequate attention. Nevertheless, even at the present time there is much that is debatable and much still to be discovered. Recent physiological work has, however, thrown considerable light on many hitherto obscure disorders of function; yet what is still unknown of certain pathological conditions is largely due to our incomplete understanding of the normal processes.

The modern developments in our knowledge will entail certain departures from the customary methods of dealing with the subjects under discussion; and more than usual importance will be attached to the pathology of the various disorders, in the belief that a proper recognition thereof is the best guide to prevention and treatment. Moreover, in the space at our disposal it will not always be possible fully to deal with the treatment indicated, for this must often be adjusted to particular cases and contingencies. It will be noticed, too, that a certain amount of repetition is unavoidable owing to the manner in which the subdivisions of our subject overlap.

PART I

DERANGEMENTS OF THE MENSTRUAL FUNCTION AND SEX CHARACTERISTICS

I. DISORDERS OF PUBERTY

Precocious Puberty

The usual age of puberty in this country is about the end of the fourteenth year, but the appearance of it between the tenth and sixteenth years cannot strictly be considered abnormal. Heredity, health, feeding and environment all play an important part in the result. When, however, a child under nine years of age shows definite signs of puberty, such as hair on the pubes, development of the breasts, and menstruation, we may look upon the condition as abnormal.

Now a close investigation of the recorded cases has shown ¹ that the production of precocious puberty in girls is not due to all those causes which may produce precocity in boys. This is a point of some importance which has been overlooked, although future observation possibly may modify the following statements, which are based upon our present somewhat limited knowledge of the subject.

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47.

On the one hand, there is no doubt that in boys sexual precocity may be produced by neoplasms and hyperplasias in the suprarenal cortices, in the testes and in the pineal,¹ and possibly also in the pituitary.² It is believed that in these circumstances there is an increase in the normal secretion of the organ concerned, except in the case of the pineal; but it is not necessary here to go into all the arguments in favour of this view.

On the other hand, our investigation of the recorded cases of sexual precocity in girls showed that true feminine sexual precocity appears to be produced by ovarian tumours and hyperplasias only;² for changes in the suprarenal cortex, the pineal and the pituitary, resembling those which in boys produce precocity, in girls tend to produce masculinity.³ Now, masculinity cannot be considered female sexual precocity; although there is little doubt that in some of the recorded cases,⁴ masculinity with, perhaps, adult manifestations, such as hair on the pubes, has been described as feminine precocity. The essential phenomena, however, associated with feminine sexual precocity are the early development of the adult feminine secondary characteristics and the functional activity of those organs which are peculiar to the female sex.

It can quite easily be understood that the mere appearance of hair on the pubes and other signs of puberty may, as explained above, have no relation to feminine precocity, but, rather, to the change to adult (or precocious) masculinity, which may be produced in a true female or in a female pseudo-hermaphrodite.

If this be so, we have only to consider precocious puberty in relation to ovarian neoplasms and hyperplasias. There is a number of such cases on record. One of the most interesting is that of a girl who was under the care of Clement Lucas.⁵ This patient, who was seven years of age, had a large ovarian tumour which was associated with early menstruation and the usual signs of puberty. After the removal of the tumour menstruation and the other adolescent manifestations disappeared. We have lately seen a girl, seven years of age, belonging to the upper middle class, who had menstruated regularly, but very scantily, with definite molimina for two years. There was slight development of the breasts, but no axillary or pubic hair. No tumour could be felt in the abdomen, but a pelvic examination was not allowed.

Roger Williams⁶ has stated that in eleven cases, which he had collected, of sexual

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47; E. E. Glynn, *Quart. Journ. Med.*, 1912, vol. v. p. 156; Roger Williams, *Brit. Gyn. Journ.*, 1902, vol. xviii. p. 85.

² W. Blair Bell, *loc. cit.*

³ But see also *The Sex Complex*, London, 1916, p. 160.

⁴ J. Orth, *Arbeiten aus den Path. Institut zu Göttingen*, Berlin, 1893 (quoted by W. Bulloch and J. H. Sequeira, *Trans. Path. Soc.*, 1905, vol. lvi. p. 189); H. A. Pitman, *Lancet*, 1865, vol. i. p. 175.

⁵ R. C. Lucas, *Trans. Clin. Soc. London*, 1888, vol. xxi. p. 224.

⁶ Roger Williams, *loc. cit.*

precocity in female children associated with ovarian neoplasms histological examinations of the tumours showed that eight were sarcomata, two cystomata and one a fibroma. The same writer has pointed out that in girls sexual precocity is not associated with excessive muscular or skeletal development, as is the case in boys. This, of course, is what we should expect, for muscularity is not a feminine characteristic.

Gaudier¹ has recorded a case in which a tumour of the ovary resembling a suprarenal cortical neoplasm gave rise to sexual precocity. If the neoplasm were really a suprarenal growth, about which there is considerable doubt, the feminine precocity must have been due to hyperplasia of the ovary caused by the tumour.

Gautier, quoted by Williams,² found that of twenty-three sarcomatous ovarian tumours in young children only four were associated with the signs of sexual precocity; consequently it must not for a moment be assumed that all ovarian tumours in young girls cause precocious development. Indeed, as we have pointed out elsewhere,³ the whole endocritic system is concerned in the development of the genital organs and their functions, and in the determination of sex characteristics; so unless there are associated changes in the other organs of internal secretion, as well as in the ovaries, sexual precocity will probably not occur.

Precocious puberty, however, in quite young girls is not usually complicated, and the treatment in the majority of cases is well defined: when there is an ovarian tumour it should be removed. These neoplasms are usually solid and often malignant; when the tumour is not benign the prognosis so far as life is concerned is extremely grave. If no growth be found, but on bi-manual examination the ovaries appear large (hyperplasia), the treatment will consist in the administration of some extract, such as that of the suprarenal medulla, which is antagonistic to ovarian secretion.

When puberty is slightly precocious, that is to say occurs between the ninth and tenth years of age, ovarian hyperplasia or neoplasia may not be found. Such cases may be due to inherited tendencies or to early development of the ovarian function with associated changes in the other endocritic organs. This in some obscure manner may be caused by the climate, feeding and surroundings of the child, or by masturbation to which reference will be made later.

The dangers of precocious puberty are habits of masturbation and excessive sexuality, leading to sexual insanity or irresponsibility. It is important, therefore, that all cases should be carefully watched, and guarded against excitements and influences likely to stimulate the already energetic functions.

¹ H. Gaudier, *Echo Méd. du Nord*, 1908, No. 30, p. 357.

² Roger Williams, *Brit. Gyn. Journ.*, 1902, vol. xviii. p. 85.

³ W. Blair Bell, *loc. cit.*; and Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. p. 937.

Absence of the Onset of Puberty

In certain pathological conditions puberty may never supervene. In such circumstances the patients are the victims of some severe general disorder, usually connected with the endocritic system. Thus with cretinism the patient remains in a condition of sexual inactivity, and the secondary sexual characteristics and functions are in abeyance.

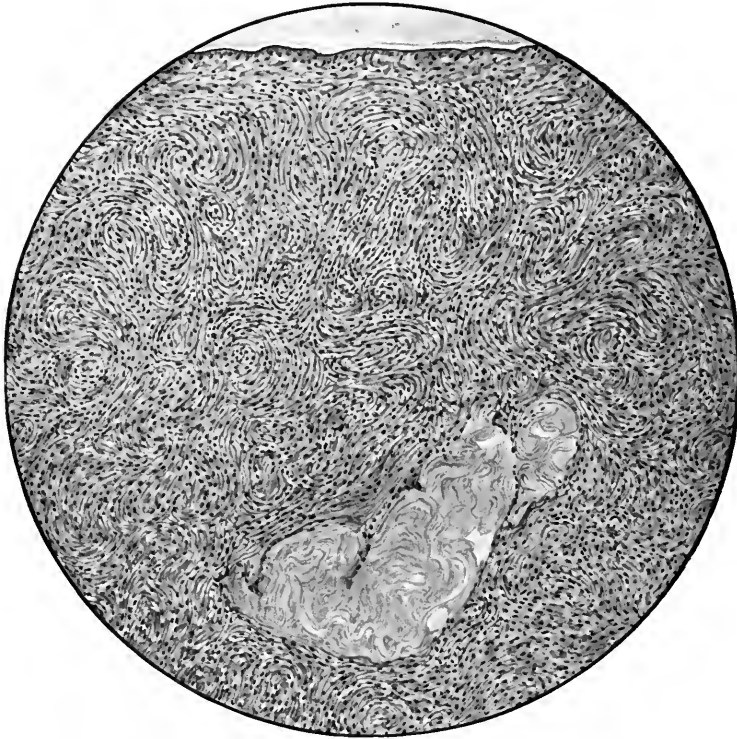


FIG. 142.—Section of ovary from a cretin, aet. thirty-three years, showing dense stroma and remains of an atretic follicle. There is a complete absence of Graafian follicles. ($\times 60$.)

In the case of a female cretin, who died at the unusually late age of thirty-three years, we had an opportunity of examining the genital organs, and the distant endocritic glands. The ovaries were large and smooth, and the uterus was well formed. On histological examination the ovaries were found to be devoid of Graafian follicles, but bands of hyaline substance, which represented the remains of atretic follicles, were seen (Fig. 142). The stroma of the ovary, which was very dense, was not composed of fibrous tissue, for it stained yellow by van Gieson's method. The endometrium contained but few glands, and these were embedded in a very dense stroma (Fig. 143). The thyroid was entirely absent, but the parathyroids were present and contained 'colloid.' The pituitary was hypertrophied and altered in structure.

This patient had taken thyroid extract for some years. It is possible that if she had been treated from an early age the genital functions might have been aroused, for there was no doubt that the development of the genital organs had advanced far beyond the foetal stage, and had, indeed, reached that seen at puberty.

Again, cortical neoplasms in the suprarenals which, as we have seen, lead to sexual precocity and muscular development in boys, cause atrophy of the genitalia

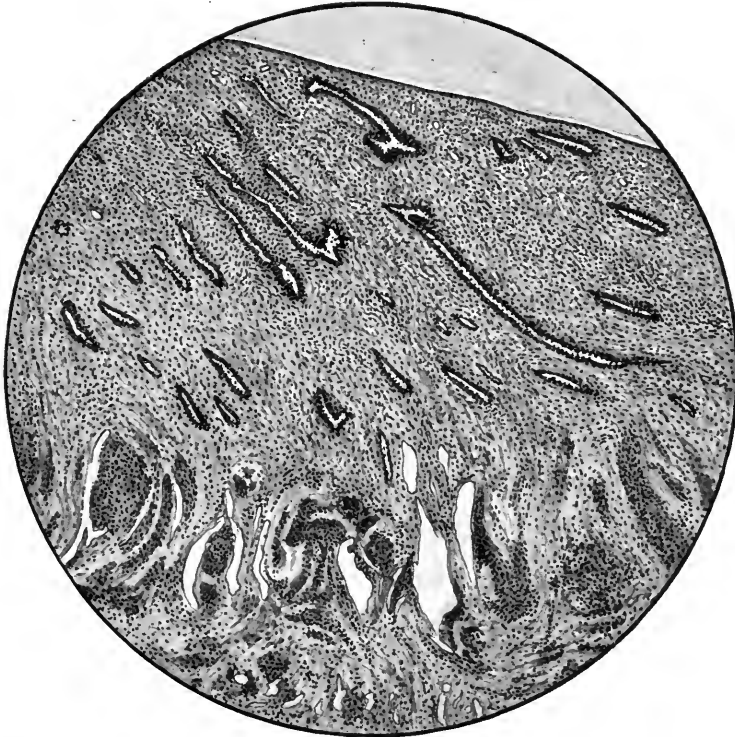


FIG. 143.—Section of uterus from a cretin, aet. thirty-three years, showing dense stroma of endometrium with inactive glands. ($\times 60$.)

in women, and if present before puberty would probably, if the child survived, prevent that period of development occurring.

With the types of infantilism described by Hastings Gilford¹ under the names of 'sexual' and 'asexual ateleiosis' the patient may remain under-developed in every respect, and the absence of sexual development is merely part of the general infantilism. It is probable that certain hormones arising from the endocritic system which normally stimulate growth and development are suppressed or are insufficient. Indeed, recently it has been shown by Byrom Bramwell² that some of these cases are due to pancreatic infantilism.

¹ Hastings Gilford, "Infantilism," Hunterian Lect., *Lancet*, 1914, vol. i. p. 587.

² Byrom Bramwell, *Edin. Med. Journ.*, 1915, New Series, vol. xiv. p. 323.

At the present time, however, our knowledge is not definite enough to allow us to lay down empirical lines of treatment in cases in which the patient remains infantile. Yet even now a careful examination of any individual case may enable us to improve the condition of the patient, if it can be traced to the imperfect action of one of the organs of internal secretion.

Incomplete and Delayed Puberty

An undue delay in the appearance of puberty is a matter of considerable importance in many cases; but first of all it will be necessary to define what we mean by 'delayed puberty.'

Strictly speaking, 'delayed puberty' should refer to the temporary non-appearance of *all* the phenomena of puberty in a girl who is past the period of life at which they appear normally. But that is not what is always implied by the term: it is often employed to denote the primary absence of menstruation in a girl who is otherwise fairly well developed, both in regard to the uterus and the secondary characteristics. Hence there is considerable confusion as to the pathological conditions which may be responsible for the delay. It will, therefore, make the discussion of the subject clearer if we consider the subject under the two headings indicated, and describe the latter first.

Incomplete Puberty.—By 'incomplete puberty' we mean that the girl arrives at puberty with all her adult secondary characteristics fully developed, but that her genital functions are in abeyance. This may occur as the result of: (1) incomplete, or incomplete and imperfect, development of the whole or part of the genital ducts with normal ovaries; (2) incomplete development of the ovaries and genital ducts, with or without imperfect formation of the whole or part of the genital ducts; (3) constitutional disturbances. Incomplete puberty is temporary or permanent according to the character of the causal factor.

With regard to the *first condition* which is very common, we usually find that the parts forming the genital ducts—Fallopian tubes, uterus and vagina—are perfectly formed but that the uterus is rudimentary or infantile, and that in consequence menstruation does not appear. We are not concerned here with the malformations as such, but only in so far as they affect the genital functions.

It is, of course, not always easy, without histological examination, to be certain that the ovaries of any given woman are active, since, as we have shown elsewhere,¹

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47; Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. p. 937.

they are not necessarily concerned in the production of the secondary characteristics. If, however, the woman have strong sexual desires and potency we may presume the presence of active sexual glands.

The causes of under-development of the uterus are now gradually being recognized. In the presence of normal ovaries we must seek for anomalies of the pituitary or of the thyroid; in the latter especially there may be insufficiency not amounting to congenital cretinism. Occasionally both organs may be at fault. (We shall not discuss here malformations associated with pseudo-hermaphroditism, which may be due to neoplasms of the suprarenal cortex.)

Recently we were consulted about a young lady, eighteen years of age, who was splendidly developed, but rather stout. The menses had never appeared. Examination of the patient under an anaesthetic revealed the fact that she had a rudimentary uterus, while the ovaries, which were palpable, appeared to be normal. On further investigation we found a low blood-pressure (100 mm. Hg.), and a high carbohydrate tolerance (350 grammes of dextrose). A diagnosis of congenital under-development of the pituitary was made, and this was confirmed by a skiagram of the pituitary fossa (Fig. 144). The measurements of the fossa in this case are indicated in the description of the figure: they are about one-half of the normal size. We believe that this is the first time such a diagnosis has been made; but on several occasions previously we had and subsequently have seen this under-development of the pituitary in cases of infantile or rudimentary uteri.

With regard to the influence of the thyroid, we usually find that the uterus is well developed, if a little small, but that menstruation does not occur when there is a slight deficiency of the internal secretion of this organ. These cases are well known, and they readily respond to treatment with thyroid extract.

In the *second class* of case with incomplete puberty the ovaries are under-developed or inactive, and the uterus is usually rudimentary or infantile and may be imperfectly developed. Such a condition is probably rare, and of course nothing can be done to remedy the state of affairs. If the experiments of Crowe, Cushing and Homans¹ be correct, congenital under-development of the pituitary might be responsible for the pelvic anomalies; but we have not yet sufficient clinical or experimental evidence that there really is ovarian atrophy in these circumstances.²

In many cases, moreover, the state of affairs must undoubtedly be due to local lesions, such as tuberculous or gonococcal infections, with pelvic peritonitis, and even in some cases to pelvic infection from appendicitis.

¹ S. J. Crowe, H. Cushing and J. Homans, *Bull. Johns Hopkins Hospital*, 1910, vol. xxi. p. 127.

² Since these articles went to press the results of our own experiments have been published in *The Sex Complex*, London, 1916.

We shall not consider here the constitutional disorders which may lead to incomplete puberty, for these will be fully discussed under the consideration of primary amenorrhoea (p. 319).

Delayed Puberty.—An undue delay in the appearance of puberty is a matter of considerable importance in many cases; but first of all it will be necessary to define what we mean by ‘delayed puberty.’

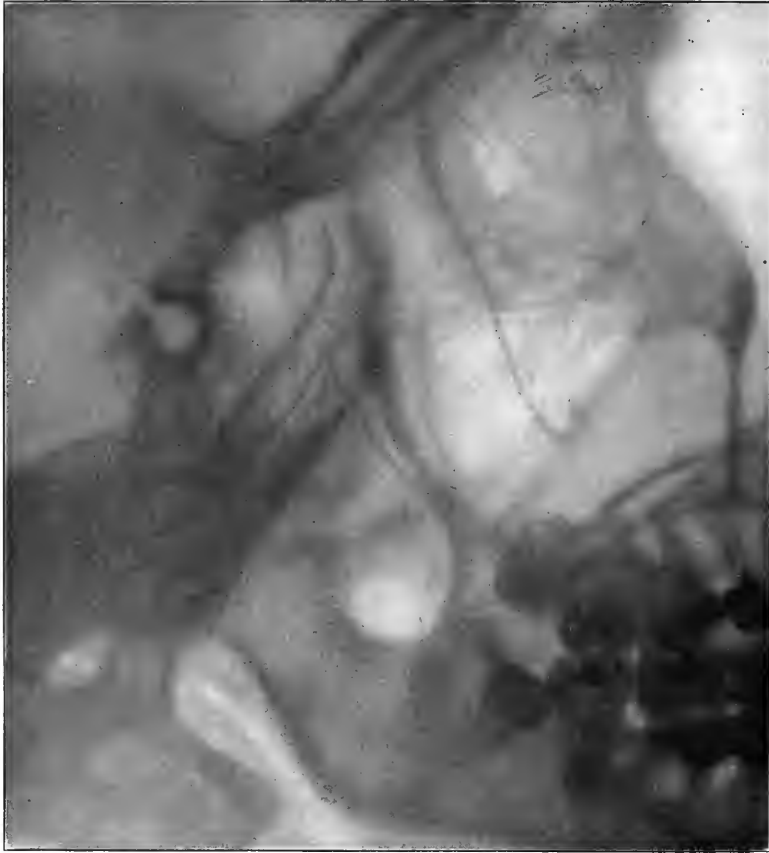


FIG. 144.—Skiagram (by Thurstan Holland) showing the sella turcica, measuring 0·6 × 0·6 centimetre, in a case of congenital under-development of the pituitary. ($\times 1\cdot$)

Strictly speaking, ‘delayed puberty’ should refer to the temporary non-appearance of all the phenomena of puberty in a girl who is past the period of life at which they appear normally (*complete delay*). But that is not what is always implied by the term: it is often employed to denote the temporary absence of menstruation in a girl who is otherwise fairly well developed, both in regard to the uterus and the second characteristics (*incomplete delay*); hence there is considerable confusion as to the pathological conditions which may be responsible for the delay.

It will, therefore, make the discussion of the subject clearer if we consider the subject under the two headings indicated.

Completely delayed Puberty.—By ‘completely delayed puberty’ we mean that not only is menstruation delayed, but also the development of the adult secondary characteristics. This condition is permanent with general persistent infantilism (*q.v.*), and temporary when there is merely delay in and not suppression of further development. We can divide the influences at work into two classes—psychical and physical.

With regard to *psychical conditions*, there is no doubt that the mental character of the individual is altered at puberty by the physical changes which occur in the body at that time: the secretions from the endocritic glands play the chief part in effecting this result. On the other hand, it is certain that the mind itself can hasten or unconsciously delay the onset of sexual activity.¹

Further, hard mental work, such as studying for examinations at school, may lead to a delay in the development of the girl. Such cases are seen by most gynaecologists, but we know of no statistics giving the age incidence of a large number of girls who have studied closely between the ages of twelve and twenty years, although Catherine Chisholm² denies that study affects either menstruation or the general health of these girls. Further investigations properly carried out would have considerable interest at the present time, especially as her results lack support (see Amenorrhoea, p. 318).

With regard to many of the *physical causes* of delayed puberty there is much conflicting evidence. It is, however, well established that general ill-health, bad feeding, unhygienic surroundings and hard work in factories tend to delay the development of the girl and the onset of puberty.

The disorders met with may be produced by the causal factors enumerated above in different ways: the food may be deficient in calcium salts which are required for building up the skeleton, before any can be spared for the reproductive functions; there may be constipation and chlorosis; or, again, hard muscular exercise or a sedentary life may each prevent the development of the sexual functions—the former by using up the reserve metabolic forces, and the latter by failing to stimulate metabolic energy.

With regard to muscular exercise evidence has been produced to show that in gymnasts puberty is delayed or incomplete; but on the other hand Angenette Parry,³ in an enquiry among members of this class of woman, found that they were nearly all normal in respect to their genital functions. The truth probably lies half way

¹ G. J. Engelmann, *Amer. Journ. Obstet.*, 1900, vol. xlii. p. 753.

² Catherine Chisholm, *Journ. Obstet. and Gyn. British Empire*, 1913, vol. xxiii. p. 288.

³ Angenette Parry, *Amer. Journ. Obstet.*, 1912, vol. lxvi. p. 341.

between these extreme statements, as was pointed out in the discussion following the paper just referred to: moderate exercise is beneficial, and excessive exercise harmful.

In races in which the women always perform muscular work, agricultural and domestic, heredity appears to play an important part; and by a process of selection women are produced whose functions remain undisturbed. The same argument may apply to healthy gymnasts, many of whom have a long line of gymnastic ancestresses. But if we were to take a girl of ten years of age from the upper classes and put her to work continuously in the factories or even in the fresh air in fields, or bring her up as a professional gymnast, it is probable that the onset of puberty in her case would be delayed, if not prevented.

In the lower classes the effect of hard work, a sedentary life, or bad feeding on the onset of puberty is in part mitigated by heredity, by the close association with the opposite sex and by the free discussion of sexual matters common among girls in this station of life; but, in spite of all, the fact remains that girls of the upper classes who are well tended commence menstruating at an earlier age than their poorer sisters.¹

Incompletely delayed Puberty.—By this term I wish to imply a *temporary* state of incomplete puberty. In these circumstances the absence of menstruation is the only abnormal phenomenon.

Incompletely delayed puberty may be caused by all the conditions just described as responsible for completely delayed puberty, and also by minor degrees of insufficiency in the internal secretions, which may not be sufficient to delay the appearance of the secondary characteristics; for instance, we usually find that, when there is deficiency of the internal secretion of the thyroid, the uterus is well developed, if a little small, but that menstruation does not occur. These cases are well known, and they readily respond to treatment with thyroid extract.

The other Disorders of Puberty

We may divide the other disorders met with at puberty into psychoses and neuroses, and those which are more strictly physical; although there is almost always a very close connexion between the psychical and physical, yet for practical purposes we must consider them separately.

Psychical Disturbances.—We have already mentioned that with the onset of puberty the physical changes in the organism produce a considerable modification in the mental attitude of the individual. The different surroundings and customs in dissimilar races, and in widely separated social classes of the same race,

¹ G. J. Engelmann, *Amer. Journ. Obstet.*, 1900, vol. xlii. p. 753.

give rise to considerable variations in the normal phenomena, and consequently in the abnormal.

In girls of civilized nations, with which we are here concerned, no greater change is produced normally than that they become reserved and modest. But, on the other hand, this very reticence and modesty may be unduly developed, and the girl become morbid and introspective. This usually occurs only in those who have a hereditary tendency to melancholia or nervous depression. In such circumstances, which often exist in the presence of unusual plainness of feature or physical deformity, the subject withdraws herself from social amenities, and avoids especially the society of men.

It is most important that such a state of affairs should be corrected by moral persuasion and by carefully selected inducements to the patient to mix freely with other people. If the patient be at all musical she should be encouraged to sing, in the first instance before members of her own family and afterwards before strangers. If she be not musical she should be induced to develop some other art or hobby which will bring her into contact with strangers and enable her to lose her self-consciousness—to acquire, in fact, self-confidence.

I. *Deficient sexuality* is, strictly speaking, a disorder of puberty, for at this period of life the girl should become endowed with the instincts and feelings of her sex. If she do not, it means one of two things: either she is permanently defective in this particular direction, or the invasion of her mind by the instincts and feelings of a normal woman is delayed.

Women vary so much in respect to sexuality, actually and potentially, that the subject is, at the present time, of philosophical rather than practical interest except to those immediately concerned. We shall not discuss the matter further here, as it will require some consideration later (p. 401).

II. *Excessive Sexuality*.—With the onset of puberty and the awakening of the sexual instincts, the stimuli provided by the developing functions may lead to a condition which is the reverse, according to our civilized standards, of that described above. In such cases the patient's psychical condition may vary from one of what we may term 'marriage-hunger' to the far worse one of 'man-hunger.' By the former we mean that girls so affected ever pursue first one man and then another with their delicate attentions, in the hope of securing a husband. The actual psychology of this common type of female is not difficult to understand, for there is no doubt that she is 'in love,' as she understands the term, on each occasion. With all her apparent immodesty, as social custom decrees it, she is nevertheless not herself aware of the impulses driving her: she has usually no consciousness of sexual desire.

The second condition, when the woman suffers with 'man-hunger,' deserves very serious consideration. There is no doubt that she is often sexually insane. Her prevailing idea is to have sexual connexion with almost every man. She has no special desire for marriage or children as the first type, mentioned above, always has; all she requires is actual sexual satisfaction. We must believe that her sexual stimuli are far in excess of the normal. If she cannot get gratification otherwise she invariably masturbates. We were consulted about one girl, sixteen years of age, who would actually write notes, take them out in her pocket and drop them for men who might be following. Her diary was a terrible document. She is now in a retreat. We have made the suggestion, for what it may be worth, that removal of the uterus and one ovary might be tried before condemning such cases permanently to an asylum.

III. *Masturbation*.—As we have already indicated, masturbation may be a sign of excessive sexuality with the desire to obtain gratification at any cost and in any manner. It may also be an accompaniment of mental instability or insanity other than that of sexual origin; and in such circumstances it is the result of a weakened moral outlook and will-power. Both of these types of case come within the province of the alienist rather than the gynaecologist; but, probably, they can be best treated by co-operation.

Another class of masturbators, who are apparently normal mentally, indulge in this practice more because it is a pleasing habit than from any idea of sexual satisfaction, of which perhaps they have neither knowledge nor suspicion. The habit is often acquired, according to Havelock Ellis,¹ in childhood from nurses or other older women playing with the child's external genitalia for their own gratification. Or it may be taught by one girl to another in a school or workroom. Havelock Ellis quotes Niccforo, who stated that all the girls in certain workrooms in Italy were known to masturbate themselves or one another in the heat of the day when the forewoman fell asleep. Again, the same author (Ellis) describes how girls sitting at sewing-machines have frequently been observed masturbating themselves by the movements of their legs. Itching about the vulva from worms or want of cleanliness may cause a child to rub the parts, and the pleasant sensation produced may lead to masturbation. A watchful mother will detect the habit, and, if the patient be taken to a physician, the cause of irritation may be removed.

If masturbation be practised at puberty and afterwards, when orgasms can be experienced, the girl may suffer in health. In one case the patient's distress and remorse at her own evil ways, which she found impossible to check, were such that we excised her clitoris and nymphae. This method of treatment may be adopted

¹ Havelock Ellis, *Studies in the Psychology of Sex*, 1913.

with excellent results if the right type of case be selected : the girl who is not suffering with excessive sexuality, but, rather, with the fascination of a bad but pleasant habit, to the detriment of her moral and physical equilibrium.

Marriage may, but does not always, cure the patient of masturbation. In many cases this practice appears to cause no harm, mental or physical.

IV. *Sexual Inversion*.—It is difficult to know how extensively practices associated with sexual inversion are indulged in by women. There is reason to suppose that true sexual inversion is not as common among females as among males ; and the evidence adduced by Havelock Ellis¹ tends to support this view. No further discussion of this subject is called for here.

V. *Hysterical Psychoses*.—Underlying tendencies to hysterical manifestations are apt to be demonstrated at puberty. Many girls appear to have their nervous equilibrium thoroughly disturbed at this time of life, and they become irritable, restless, and unreasonable. In other words a girl of neuropathic tendencies is extremely liable to have nervous disturbances precipitated by the metabolic changes at puberty. Such a patient is often fairly composed between the menstrual periods, but is prone to the so-called 'hysterical fits' during menstruation. In these circumstances the 'fits' assume some of the appearances of epilepsy, but the patient never passes urine or faeces during the paroxysm, nor does she injure herself by biting her tongue or knocking her head.

'Hysterical fits,' we believe, differ from hystero-epilepsy (*q.v.*) by their inconstancy, in their origin and from the fact that the former can be controlled while the latter cannot. Osler,² however, considers that hystero-epilepsy is a major form of hysteria.

This tendency to 'fits' may be associated with illusions, hallucinations and other mental disturbances ; sometimes the patients have been known to have cataleptic seizures.

Neuroses.—The neuroses occurring at puberty may be sensory, motor or visceral. These have been fully investigated by physicians, and a clear account is given by Osler,² which should be referred to by those interested in the subject. Here it will be sufficient to recall the chief manifestations.

Sensory Disturbances.—There may be anaesthesia or hyperaesthesia, or the special senses of taste, smell, vision or hearing may be impaired or deranged, giving rise to unpleasant tastes and smells, to photophobia, or to continuous noises.

Motor Derangements.—(*a*) *Chorea*.—True chorea occurs very much more

¹ Havelock Ellis, *Studies in the Psychology of Sex*, 1913.

² W. Osler, *The Principles and Practice of Medicine*, 1912.

frequently in girls (70 per cent) than in boys. At the same time it is not a disease which is more than incidentally connected with puberty. The psychical element in true chorea is very marked, although often overlooked ; and, whatever the usually accepted etiology may be, there is no doubt fear or fright is frequently a causal factor in the onset. So it comes about that the disease is common during the period of nervous tension which may be found at puberty in girls of a neuropathic temperament. False chorea, or 'habit spasm,' is, likewise, most frequently seen in girls from ten to fourteen years of age. Twitchings of the face or limbs are the commonest movements. These habits tend to disappear as the girl grows up and her nervous system becomes less irritable.

(b) *Paralyses* may be paraplegic, hemiplegic or monoplegic ; indeed any known form of organic paralysis may be simulated.

(c) *Contractures and spasms* are very common in hysterical patients, but not so frequently at puberty as at the menopause.

Visceral Manifestations.—These are most common in regard to :

(a) *Respiratory* mechanism, which may be altered in rhythm, or there may be a 'catching' during inspiration. Occasionally there is a spasmodic cough.

(b) *Alimentary* disturbances, such as a depraved appetite, are not uncommon. Sometimes there is incessant regurgitation of food, or there may be difficulty in swallowing. Diarrhoea or extreme constipation may be seen.

(c) *Cardio-vascular* disturbances are very common : flushing of the skin, palpitation and rapid alterations of the cardiac rhythm are most frequently observed.

Physical Disturbances.—We have alluded already to those general disturbances which lead to precocious development and to absence or delay of puberty. We must now refer to a few disorders which are specially prone to occur at this period of life, although they may and do occur at other times.

A. *General Disorders.*—I. *Ductless Glands.*—(a) *The Ovaries.*—Normally the ovaries, which may have been active both in regard to ovulation and internal secretion before puberty, at this time begin to expel ova regularly and to increase the output of a specific hormone. Now these functions may not develop fully, and, in consequence, the menses are irregular and scanty. The condition is best ignored for a time, since many girls who are irregular at the commencement of menstruation subsequently become quite normal.

Contrariwise, the excessive menorrhagia of puberty may sometimes be due to the unbalanced action of particularly active ovaries. In such cases extract of the suprarenals or pituitary should be administered. There is no doubt that in time, even without treatment, these patients usually become regular ; meanwhile, how-

ever, it may be necessary to check the menorrhagia lest the girl become anaemic or even seriously ill. (See also p. 343.)

(b) *The Thyroid*.—Enlargement of the thyroid is a phenomenon well recognized at puberty. Probably some change always occurs normally, but unfortunately, as in so many aspects of the problems associated with the organs of internal secretion, sufficient work has not been carried out on the age variations in the structure and functions of these glands to enable us to speak with certainty. This hiatus in our knowledge will shortly be bridged over, but until then we must be content to draw what conclusions we can from the incomplete information at our command.

Clinically we observe this enlargement at puberty in two types of case. On the one hand, it is associated with free—perhaps too free—menstruation which may be painless; and, on the other hand, we see enlargement of the thyroid associated with scanty menstruation and dysmenorrhoea.

We have observed that in the first variety of case the enlargement of the thyroid tends to persist between the periods, while in the second the enlargement is pronounced only during menstruation. It must, of course, be understood that there are many grades between these extremes, and a constant slight enlargement of the thyroid with an increase in size at the menstrual periods is probably the commonest of all. We are not discussing the early stages of Graves' disease, but simply the enlargement of the organ due to the changes in and demands of the organism at this time of life.

Mothers are often very anxious about what they describe as 'the goitre,' even when the menstruation is normal. In nearly all cases we may assure her that the thyroid enlargement has no clinical significance beyond indicating the sensitiveness of this organ in women; in fact, in the vast majority of cases we may inform those concerned that the process is normal. On the other hand, it is surprising how frequently girls with enlarged thyroids, which have passed unnoticed, are brought to us suffering with some derangement of menstruation. It is important, therefore, to observe the condition of this gland in all patients with menstrual disturbances.

When treatment is required it is on account of the menstrual condition; and it is often remarkable how, when improvement is effected, a diminution in size of the thyroid gland follows. These pathological phenomena—menorrhagia, dysmenorrhoea and scanty menstruation—will be dealt with in the proper place, so it will be sufficient here to indicate the lines of treatment which are based on the foregoing considerations. In those cases in which there is menorrhagia the thyroid is over-active, and treatment with calcium lactate and pituitary extract is indicated. On

the other hand, when there is amenorrhoea or scanty menstruation with dysmenorrhoea the enlargement of the thyroid is, we believe, indicative of an endeavour on the part of the organism to utilize the secretion of the thyroid to augment an insufficient secretion from the ovaries. Hence in such cases thyroid extract may be administered with benefit, or even thyroid and ovarian extracts together.

(c) *The Pituitary*.—Harvey Cushing¹ states that acromegaly usually commences at puberty; and he gives this and other reasons for believing that the pituitary enlarges normally at this period of life, and that an unchecked hyperplasia of the anterior lobe gives rise to this disease. Since acromegaly is frequently followed by the condition of *dystrophia adiposo-genitalis*, there may be a similar explanation of some of those cases in which a girl after menstruating regularly for some years becomes very fat and suffers with amenorrhoea.

(d) *The Suprarenals*.—The cortex of the suprarenal is intimately connected with the full development of the normal characteristics, but we have no evidence as yet that disturbances of its function occur more frequently at puberty than at other times of life. Indeed, the evidence of recorded cases is rather to the contrary, since cortical hyperplasias have been found most frequently in children or in women over twenty years of age. In the few cases which have occurred at or soon after puberty amenorrhoea has, of course, been associated with the development of masculine characteristics.²

II. *Dermatoses*.—We are indebted to Dr. R. W. Mackenna for the following details concerning the relation of puberty to various disorders of the skin.

At puberty the glandular activities of the skin become increased, and this additional activity may assume pathological proportions; for hypersecretion of the sebaceous glands is accompanied by an enlargement of the sebaceous orifices, which, on the face, shoulders and chest frequently become blocked by a plug of horny scales and fatty secretion (comedo), sometimes containing the bacillus of acne. The comedo interferes with the escape of sebum, which accumulates behind it and subsequently may become contaminated by the *staphylococcus epidermidis albus* or *aureus*—the causes of pustular acne (acne vulgaris). Acne usually develops coincidently with the onset of puberty in the female, and is subject to exacerbations at each menstrual period. On the scalp, the increased secretion of the sebaceous glands is associated, at first, with a tendency to an increased growth of hair; subsequently, if the sebaceous secretion become excessive it may accumulate on the scalp in the form of greasy scales, which tend to choke the pilo-sebaceous orifices

¹ Harvey Cushing, *The Pituitary Body and its Disorders*, 1912.

² W. Bullock and J. H. Sequeira, *Trans. Path. Soc.*, 1905, vol. lvi. p. 189; E. E. Glynn, *Quart. Journ. Med.*, 1912, vol. v. p. 156.

and kill the hair. This collection of 'dandruff' forms a suitable nidus for the multiplication of organisms which may further increase the tendency of the hair to fall out. The irritating sebaceous secretion may, too, be spread down behind the ears and over the cheeks, giving rise to seborrhoeic dermatitis. This condition is characterized by fawn-coloured, greasy, circinate or petaloid lesions which tend to coalesce, and may also appear on the chest and back at this period of life.

Many other dermatoses, especially those associated with the nervous mechanism of the skin, become aggravated at the menstrual periods.

It is a remarkable fact, the precise meaning of which has not yet been determined, that ringworm of the scalp is rarely seen after puberty.

III. *Chlorosis*.—Anaemia of this variety never occurs in boys, but is very common in young women about puberty—between the fourteenth and seventeenth years (Osler¹); indeed, it is rare to see it at any other period of life. Osler also states that "there exists a lowered energy in the blood-making organs, associated in some obscure way with the evolution of the sexual apparatus in women."

This disease is most common in badly-fed, delicate and constipated girls. The deficiency in haemoglobin in the blood is difficult to explain in connexion with the developing genital system, and as yet no completely scientific explanation has been given. Amenorrhoea or scanty and irregular menstruation are inevitable concomitants of the disease. It is stated by some² that menorrhagia may be produced by chlorosis; but it seems more probable that in cases of chlorosis associated with menorrhagia the latter is the cause of the former, and not *vice versa*.

Some years ago we treated several hundreds of patients with chlorosis in a large institution by the administration of big doses of *ferrum redactum* with the most remarkable results. The method of treatment was as follows: Reduced iron was taken three times a day in bread-and-butter sandwiches directly after the principal meals. To start with, three grains were given for each dose. Every other day one of the doses was doubled until at the end of a week the whole quantity taken was six grains three times a day. The dosage was increased in this way up to *twenty-four grains three times a day*, a quantity far in excess of the pharmacopoeial maximum. When the desired effect had been obtained the quantity administered was reduced at the same rate as the increase was made. The patient was always advised to lie down for half an hour after taking the iron, until her stomach tolerated it without difficulty. The bowels were kept open every day. Menstruation was almost invariably re-established after a few weeks' treatment, and the chlorosis cured.

¹ W. Osler, *The Principles and Practice of Medicine*, 1912.

² J. Halliday Croom, *System of Gynaecology*, edited by Allbutt, Playfair and Eden, 1906, p. 85.

B. *Local Disorders*.—I. *Genital*.—The disorders which occur in regard to the genitalia at puberty are those connected with the function of menstruation, and these may be influenced by derangements in the development of the genital canal. All these disorders will be considered later under the respective headings of ‘Amenorrhoea,’ ‘Menorrhagia’ and ‘Dysmenorrhoea.’

II. *Vesical Disorders*.—Not infrequently about puberty girls have either nocturnal enuresis, inability to retain the urine day and night, frequent micturition or, sometimes, retention of urine. It is often difficult to discover whether these conditions are due to local causes or whether they depend upon disturbances in the nervous system. When the vesical trouble only occurs at the menstrual period it is probably due to the local congestion which may affect the bladder. This condition may be relieved when the menstrual discharge is scanty by the administration of thyroid extract, which, if given in one-grain doses every night, will accelerate the onset of menstruation and in this way lessen the pelvic congestion. The bowels also should be carefully regulated for the same reason.

If, however, the trouble be of nervous origin it is most difficult to treat, especially when the disturbance is frequent micturition. The patient should live in the fresh air, not be allowed to overwork mentally or indulge in strenuous physical work or exercise. Tepid (nearly cold) baths in the morning should replace the hot bath usually preferred by girls in the upper classes; the bowels should be regulated with paraffin; all vesical irritants, such as alcoholic stimulants, tea and coffee, should be forbidden, and red meat avoided. The administration of belladonna sometimes gives good results, but as a rule drugs are of little value, and we rarely prescribe them in these cases of nervous origin. Psycho-therapy may be given a trial in obstinate cases.

When there is periodic retention—a rare condition—it usually occurs from temporary paralysis of the bladder due to over-distension. If, however, the state of affairs tends to recur after catheterization, the patient should be instructed to empty the bladder regularly every three hours during the day and before going to bed at night. Strychnine or pituitary extract may be employed medicinally to increase the tone of the vesical musculature.

II. DERANGEMENTS OF THE SEX CHARACTERISTICS

It has never been conclusively shown why a foetus develops into either a male or female. We must pass over any discussion of the original controlling force, which is probably latent in the ovum and spermatozoon, for it is beyond our definite knowledge, although important facts have recently come to light concerning sex differentiation in certain insects. But when we come to consider the differentiation of

characteristics after the sex is primarily determined, there is much that is of the greatest clinical importance.

There are, however, many who believe that the primary differentiation is carried no further than the gonads, and possibly the rest of the genitalia; that the secondary characteristics are dependent on the nature of the genital glands, and that otherwise a woman differs not at all from a man. This opinion is based on the desire of many to consider man and woman as identical except in so far as the local functions of the genitalia may be concerned.¹ To any unbiassed observer such an attitude is difficult to understand. Indeed, were there any scientific justification for it we should have little further to say on the subject under discussion. As it is, we have facts to bring forward which are of importance now and will be of greater importance before many years have passed.

It is our belief that the more truly feminine a woman is, psychically and physically, in instinct and in performance, so much the more complete and normal will be the functions of her mind and body.

We have already alluded to inverted instincts; and in the perversion of functions and characteristics (physical phenomena) we may observe all grades from almost complete masculinity in appearance, with the disappearance of the feminine functions, to the lesser degrees of disordered functions and characteristics.

It is beyond our province to give here a detailed description of those strange congenital freaks of nature in her most evil mood which may occasionally be met with: the male and female pseudo-hermaphrodites—individuals in the one case with the external characteristics of women and with feminine minds in conjunction with masculine gonads, and, in the other, with masculine characteristics and attributes in association with ovaries.² But we would like to mention two points in connexion with pseudo-hermaphroditism which have considerable bearing on much that we have to say.

Firstly, these cases go to show that the secondary sex characteristics are by no means entirely dependent on the genital gland, as many would have us believe. In support of this statement, if such support be needed at the present time, we may mention one case—never published in detail—of a male pseudo-hermaphrodite under the care of H. Russell Andrews, to whom we are indebted for permission to make use of it. This patient at the age of nineteen years was a good-looking young 'woman.' 'Her' hair was long, 'her' breasts well developed, and 'her' figure and limbs of

¹ Louise M'Ilroy, Discussion following paper, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii, p. 78.

² This subject is more fully dealt with in the Article on Malformations (p. 277).—EDITORS.

truly feminine proportions and shape (Fig. 145). The skin was smooth and soft. 'Her' voice was treble. The external genitalia and pubic hair were of the normal



FIG. 145.—'Male pseudo-hermaphrodite' with well-marked feminine characteristics.
(Photograph kindly lent by H. Russell Andrews.)

feminine type. There was a short pouch representing the vagina (urogenital sinus), normal labia and a small clitoris. The internal genital organs consisted of two testes attached to definite gubernacula. A section of one of the testes is shown in Fig. 146.

Secondly, it has been shown¹ that of eighty-eight cases of female pseudo-hermaphroditism, collected by Neugebauer, in 15 per cent suprarenal cortical neoplasms and hyperplasias were found *post mortem*; whereas, in only 0·7 per cent were these suprarenal lesions found in the male pseudo-hermaphrodites examined. This indicates that derangements of the suprarenal cortex during foetal development may affect the primary as well as the secondary characteristics, just as neoplasms and hyperplasias of this structure later in life may alter the secondary.

We shall now discuss shortly the pathology of the production of masculinity in females previously normal, and demonstrate the dependence of the sex characteristics on the internal secretions other than those produced by the gonads.

We have already referred at some length to the subject when discussing precocious puberty, and there will, accordingly, be some unavoidable repetition.

The secretions of the endocritic glands which have produced the normal female continue subsequently to act in the same way—passively, no doubt—and it is only some extensive alteration in the structure and function of certain units of the internal secretory system which can bring about an alteration in the female sexual characteristics, once they have been determined and the genital organs have become function-

¹ E. E. Glynn, *Quart. Journ. Med.*, 1912, vol. v. p. 156.

ally active. So far as we know, the withdrawal of any one secretion will produce no change. There must be some overgrowth in those parts of the endocrine system, apart from the genital glands, which normally produce masculinity—a potentiality which appears to be concentrated in the suprarenal cortex, the pineal body and probably in the pituitary.

Apert¹ has asserted that masculine characteristics may be produced in women by simple ovarian tumours. But, as Glynn² points out, there is no evidence in the



FIG. 146.—Section of testis from 'male pseudo-hermaphrodite' seen in Fig. 145, showing functionless seminal tubules and masses of interstitial cells. ($\times 60$.)

cases reported that the suprarenals were examined, or, we might add, the pituitaries and pineals. It is interesting in this connexion that at the time of writing we should have under our care a girl, nineteen years of age, whose case might have been wrongly taken to support the view of Apert mentioned above. At fifteen years of age this patient commenced menstruating, and was regular for eighteen months; since that time there has been complete amenorrhoea. We saw her first two years ago when we made a diagnosis of hyperplasia of the suprarenal cortex, and alluded to the case briefly elsewhere.³ About the time of the cessation of

¹ M. E. Apert, *Bull. M d.*, Paris, 1910, vol. xxiv. p. 1161.

² E. E. Glynn, *Quart. Journ. Med.*, 1912, vol. v. p. 156.

³ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47.

menstruation her voice began to 'break.' She now has a bass voice and her larynx is masculine in type. The outer sides of her thighs are covered with dark hair, she has a moustache, and the pubic hair grows up to the umbilicus (Fig. 147);



FIG. 147.—So-called 'true hermaphrodite,' who had an ovo-testis on the left side. (Photograph.)

there is also a profuse growth of hair in the perineal region. Her breasts are flat, and the clitoris is greatly enlarged, measuring nearly two inches in length. The thyroid is slightly enlarged. On bi-manual examination nothing abnormal was discovered except a slight increase in the size of the left 'ovary.' No tumour could be felt in the abdomen.

Laparotomy was performed to discover the condition of the abdominal and pelvic viscera. The right ovary was found to be small, while the left gonad was enlarged to the size of a plum, but was quite smooth and soft. A piece was excised from each genital gland for histological examination. The stroma in the right ovary was found to be dense, but otherwise the organ was normal. The left gonad was apparently the seat of a curious growth: it had some of the histological appearances of an adenocarcinoma, and was reported by the pathologist as such; consequently we re-opened the abdomen

and removed the ovaries, tubes and fundus uteri. We ourselves, however, on investigating further this peculiar 'growth,' typical portions of which are shown in Fig. 148 and Plate VI., came to the conclusion that this organ was an ovo-testis. At both laparotomies the regions of the suprarenals were palpated. No tumour could be felt, and we are inclined to think there was no abnormality in these organs.

It is, therefore, probable that the masculinity in this case has been caused by the masculine elements in the left ovary, in conjunction with correlated changes in the



Section of ovotestis from the so-called "true hermaphrodite" seen in Figure 147, showing seminal tubules, and eosinophile interstitial cells in the testicular portion. This figure is a higher power view of the portion shown enclosed in a circle in Figure 148.

× 250

other endocritic organs. If the masculine characteristics have been due to the ovo-testis alone it will be interesting to observe if they now disappear. A detailed account of the case will be published at a later date,¹ as it is one of unusual importance.

So-called true hermaphroditism is, therefore, to be remembered in connexion with the alteration of sex characteristics and functions, although a description of this condition does not fall within the present discussion.

It will not be waste of time, however, to digress for a moment in order to consider the essential differences that occur in the metabolism in response to stimulation from the masculinity-producing secretions. Probably the most important and obvious changes are associated with the metabolism of the lime salts. The male skeleton is much heavier and stronger than that of the female, consequently in men one of the most essential metabolic conditions is a considerable calcium retention during growth; besides, normally there appears to be in men a stable or but slightly variable metabolism of calcium during

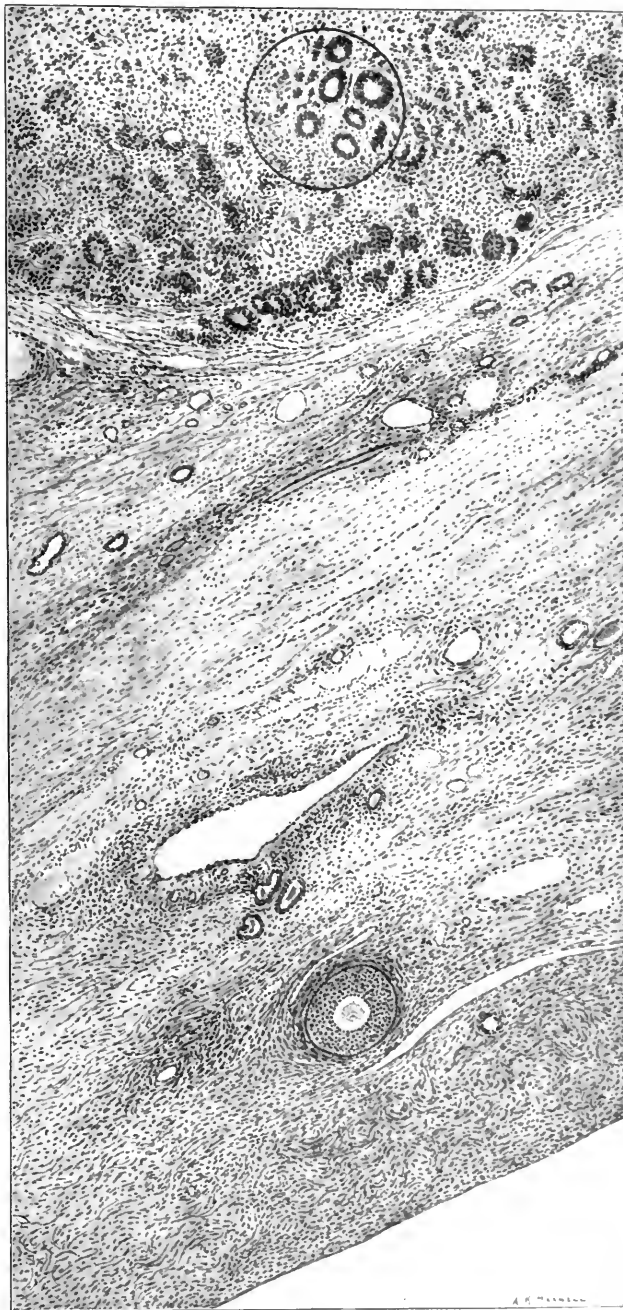


FIG. 148.—Section of ovo-testis from the so-called 'true hermaphrodite' seen in Fig. 147, showing above testicular portion in the centre of the organ and below ovarian portion forming the capsule. ($\times 40$.)

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1915, vol. viii, p. 77.

the reproductive period. With women, however, there is less calcium retention during growth; and throughout her reproductive life rapid alterations in the metabolism of lime salts occur during menstruation, pregnancy and lactation. It is not surprising, therefore, to find that those parts of the endocritic system which are largely concerned in the storage of calcium and the building up of the skeleton should also, when abnormally active in the female, produce, or lead to

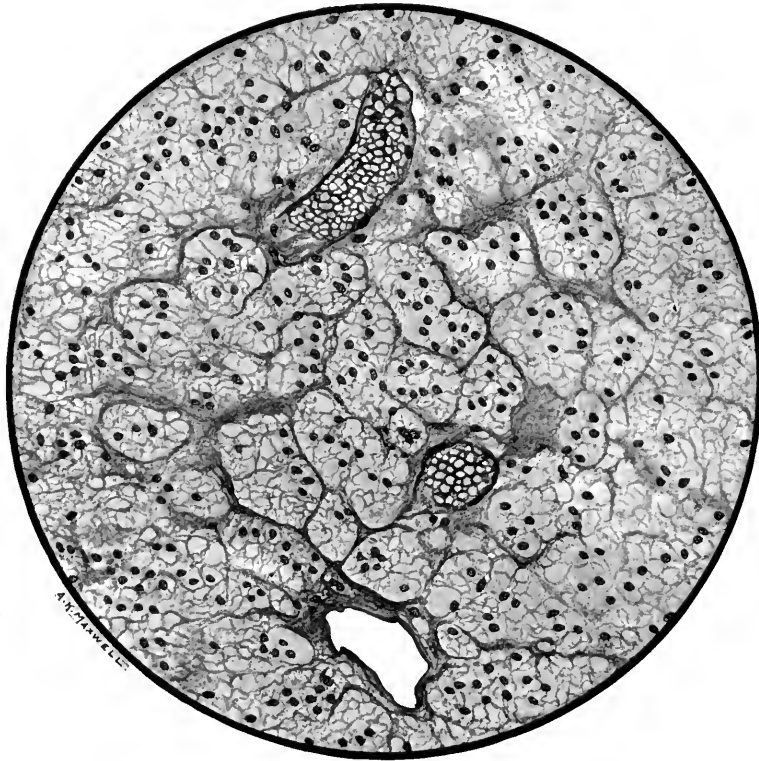


FIG. 149.—Section of the suprarenal cortex from a woman who had developed masculine secondary characteristics, showing hyperplasia. ($\times 250$).
(From section kindly lent by E. E. Glynn.)

the production of, other masculine characteristics, such as growth of hair on the face, and alterations in the formation of the larynx and breasts.¹

As we have already seen, overgrowth or tumour formation in the suprarenal cortex in girls before puberty leads to the production of male characteristics. These growths have generally been found to be malignant, so no ultimate history has, as far as we know, ever been obtained in regard to the cases recorded in young girls. In adult women, before the menopause, the changes towards masculinity

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47.

associated with suprarenal hyperplasia (Fig. 149) and neoplasia (Fig. 150) may be most marked. Menstruation ceases, the breasts shrink, the clitoris enlarges, hair grows on the face and on the body with masculine distribution, the voice deepens, and last, and not least, profound psychical changes have been known to occur, a previously gentle woman becoming rough and aggressive. A number of such cases has recently been collected.¹

With acromegaly, too, we have observed a somewhat similar change. In one

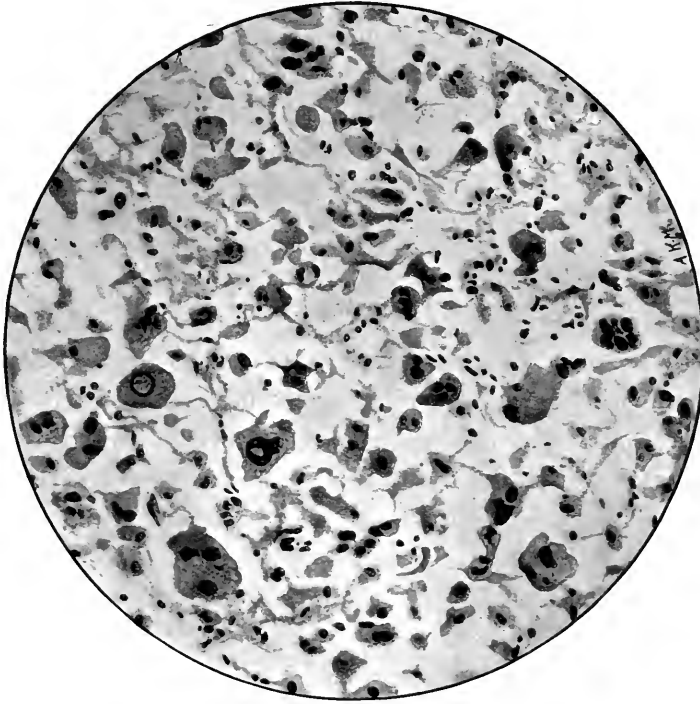


FIG. 150.—Section of suprarenal cortical tumour from a woman who had developed masculine secondary characteristics, showing neoplasia (hypernephroma). ($\times 250$.)
(From section kindly lent by E. E. Glynn.)

case menstruation ceased, the skin became coarse, the voice deep, the breasts shrunken, and last, and most interesting of all, the clitoris hypertrophied until it resembled a small penis.² We know that in the male acromegaly (hyperpituitarism) may at first give rise to increased sexuality,³ consequently the reverse obtains in the female, in whom there is a tendency towards masculinity. In the case of the internal secretions of the pituitary, therefore, we see evidence of a difference of sex stimulation in

¹ E. E. Glynn, *Quart. Journ. Med.*, Oxford, 1912, vol. v. p. 156; E. E. Glynn and J. T. Hewetson, *Journ. Path. and Bacteriol.*, Cambridge, 1913, vol. xviii. p. 81.

² W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47.

³ Harvey Cushing, *The Pituitary and its Disorders*, 1912.

the male and the female, just as we saw it in connexion with the suprarenals and pineal.

The thymus appears to take no definite part in the regulation of sex characteristics in spite of its supposed influence over the formation of the skeleton. Further investigations may, however, prove that it is more immediately concerned than now appears probable.

It will be clear from what has been said that we must investigate these cases very carefully when we are confronted with problems affecting either the mind or physical functions and characteristics of our patients ; for, as we have already stated, it is hardly to be expected that every case of masculinity will be outspoken ; indeed, we have reason to believe that the reverse is often the case.

III. DERANGEMENTS CONNECTED WITH THE MENSTRUAL FUNCTION

Cryptomenorrhoea

Retention of the menstrual discharge, which is sometimes considered a variety of amenorrhoea, may be due to congenital or acquired lesions.

The congenital atresiae which cause retention of the menses require but brief mention here, for the essential anatomical anomalies responsible for the various conditions which may be met with have already been fully considered elsewhere in this work (p. 261). We may, however, devote a little space to certain symptoms and to points of functional interest, and also to a matter of morphological importance which we have recently described.

The commonest abnormality producing retention of menses is imperforation of the lower end of the vagina (Figs. 151 and 152), which, by preventing the escape of the discharge, causes an accumulation known as '*haematocolpos*.' Now this obstructing membrane, which results from the incomplete 'perforation' of the vagina, has usually been described as an imperforate hymen (Plate V. p. 277). Our investigations have, however, enabled us to show conclusively¹ that in most cases this membrane, whether thick or thin, is not hymen.

In the first place, the hymen can often be seen stretched round the periphery of the obstructing membrane which is bulged outwards by the pressure of the retained menses. This is well shown in Fig. 151. Sometimes, however, the hymen is spread over the surface of the obstructing membrane in the form of a central band or as scattered bands (cribriform) (Fig. 152) ; and in these circumstances the hymen

¹ W. Blair Bell, *Journ. Obstet. and Gyn. Brit. Emp.*, 1912, vol. xxi. p. 209.

is adherent to the underlying membrane. In Fig. 153 a short edge of hymen springing from the outer surface of the obstructing membrane is shown in section.

We have discussed the development of the vagina and hymen elsewhere, and cannot refer to the subject here; but since the publication of that work¹ we have investigated many cases of haematocolpos, and in sixty per cent of the obstructing



FIG. 151.—The obstructing membrane in a case of haematocolpos, with the hymen stretched round the periphery.
(From Blair Bell's *Principles of Gynaecology*.)

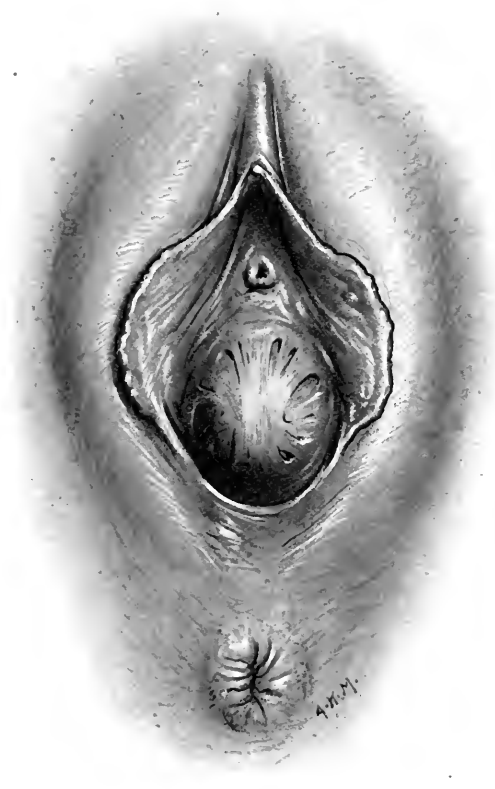


FIG. 152.—The obstructing membrane in a case of haematocolpos, with the hymen stretched over the external surface and presenting a cribriform appearance.

membranes examined we found *columnar epithelium on the inner surface*. This proved that such membranes were of Müllerian (or Wolffian) origin. The hymen is not developed from these structures. In some cases the whole of the inner surface, and therefore the vagina, was covered with pure columnar epithelium, in connexion with which glands were often observed (Fig. 154). In others columnar was lying adjacent to squamous epithelium (Fig. 155), the result, no doubt, of the columnar

¹ *The Principles of Gynaecology*, 1910.

epithelium undergoing metaplasia into squamous epithelium, for in some sections transitional forms of epithelium were to be seen.

At first the retention of the menses produces no symptom sufficient to call attention to the local condition, and the case is looked upon by the mother of the patient as one of delayed menstruation, for which advice may be sought. Sometimes there are definite menstrual molimina each month: the patient complains of headache, backache and lassitude. As the collection of retained menses increases

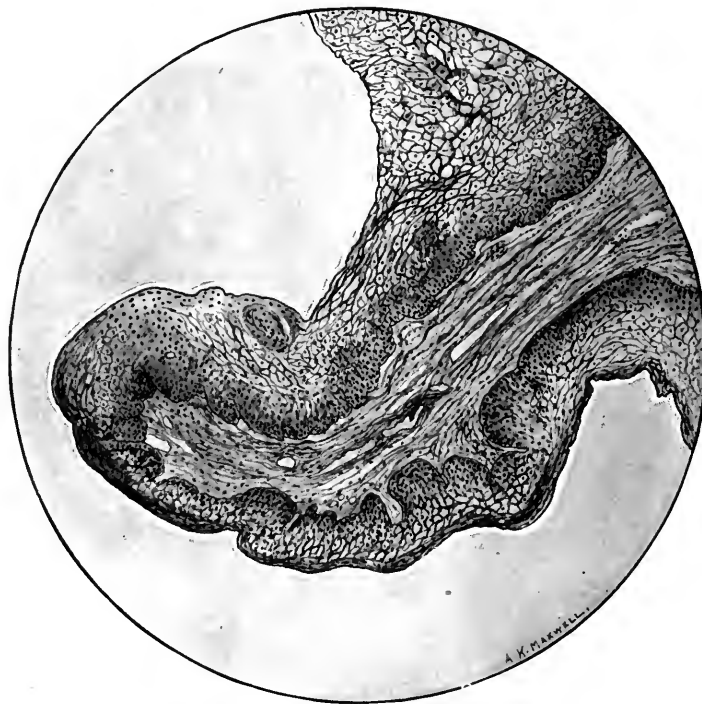


FIG. 153.—Section of obstructing membrane from a case of haematocolpos, showing an edge of hymen projecting from the outer surface. ($\times 60$.)

in size the local molimina may increase in severity. In at least half of all cases, however, molimina are entirely absent. The symptom for which the patient seeks advice is practically always dysuria or retention of urine.¹ Apart from the pressure on the bladder the patient usually does not complain of the tumour, which may reach a very large size.

The structural malformation giving rise to cryptomenorrhoea varies, but from a broad standpoint the essential anomalies consist of obstruction at the lower end of the vagina or at the cervix. The site of the lesion is of importance from the point

¹ W. Blair Bell, *Journ. Obstet. and Gyn. Brit. Emp.*, 1912, vol. xxi. p. 209.

of view of subsequent function. If the vagina be imperforate at its lower extremity a very simple operation is sufficient to remedy the condition. Then, if the patient be under twenty years of age—as is almost invariably the case when the condition is discovered—the uterus is not distended, and a perfect functional result is obtained; that is to say, the girl will subsequently menstruate regularly and may become pregnant. If, however, the stenosis be at the cervix uteri the condition is not usually discovered until later in the life of the individual, owing to the absence of

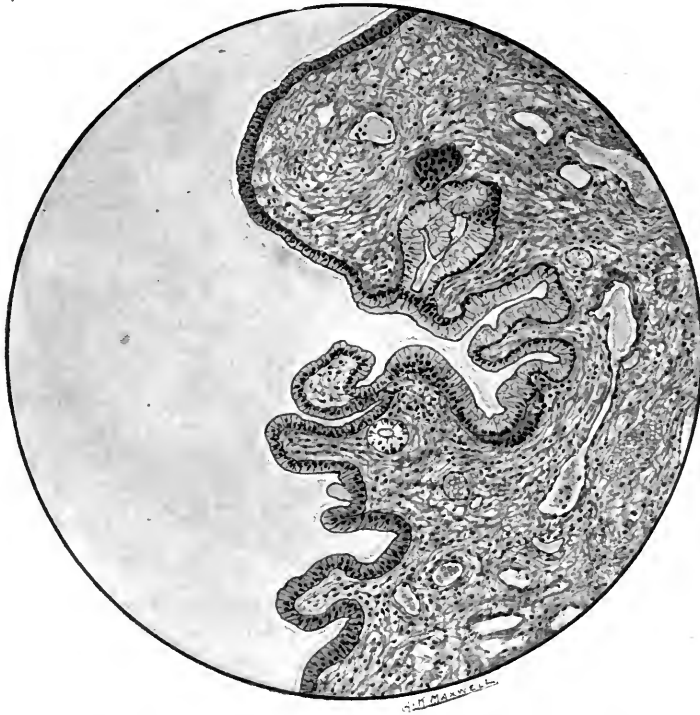


FIG. 154.—Section of the obstructing membrane in a case of haematocolpos, showing pure columnar epithelium and glands lining the inner (vaginal) surface. ($\times 60$.)

definite symptoms apart from the non-appearance of menstruation; consequently the uterus and tubes become distended with menstrual secretions ('*haematometra*' and '*haematosalpinges*'), and are so damaged that their ultimate functional recovery is impossible, even though the cervix be opened up. Indeed, the proper treatment nearly always consists in removing the affected organs.

Acquired atresiae, like the congenital malformations, occur in the cervix or vagina. Injuries or septic infections are the factors which, by damaging the tissues, lead to occlusion by a process of scarring or by the adhesion of adjacent surfaces.

Stenosis of the cervix may result from difficult parturition, cauterization of the cervix or badly performed amputations. Occasionally rotation of the body of the uterus on the cervix, new growths blocking the canal or senile stenosis may lead to retention of the menses or secretions of the endometrium in the uterus.

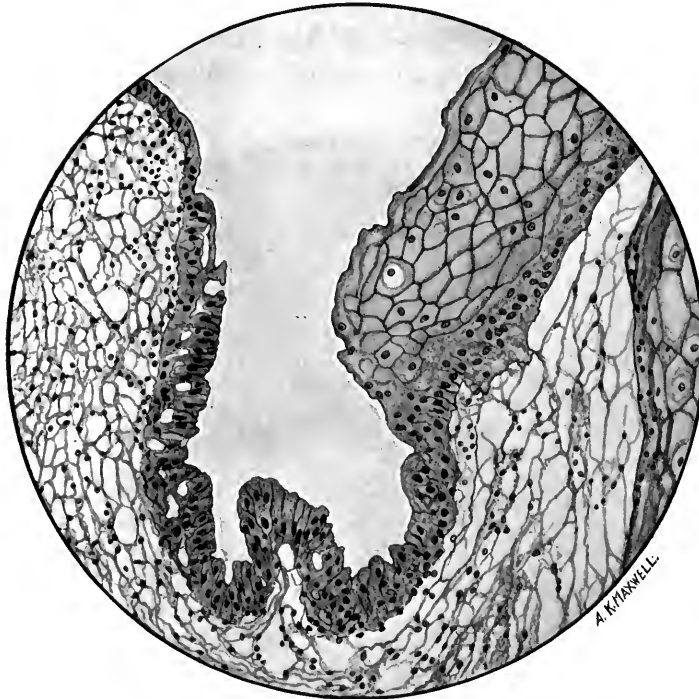


FIG. 155.—Section of the obstructing membrane in a case of haematocolpos, showing both columnar and squamous epithelium lining the inner (vaginal) surface. ($\times 250$.)

Occlusion of the vagina usually occurs at the orifice, and is most commonly the result of vulvo-vaginitis in childhood.

The symptoms and treatment are practically the same as in the case of congenital atresiae.

Amenorrhoea

Suppression of the function of menstruation may occur as a primary or secondary disorder, and it will make for clearness if we consider the subject of amenorrhoea under these main divisions. There is, of course, a considerable overlapping of the causes concerned, for a disease which prevents the onset of menstruation will also suppress the menstrual function after it has been established. For this reason some prefer to classify amenorrhoea according to whether it be congenital or acquired ; but owing to the difficulty arising from the fact that there are two stages in the

development of the genitalia—foetal and pubescent—we prefer the classification first mentioned.

Primary Amenorrhoea.—Primary amenorrhoea may be subdivided into *permanent* and *curable* amenorrhoea. The causes producing primary amenorrhoea may be either *congenital* or *acquired*, and in each case the causal factors may be *general* or *local*.

A definite distinction must be made between primary delay in the appearance of menstruation and completely delayed puberty, as we have already pointed out. In the former the signs of puberty, with the exception of menstruation, are all present. In the latter *all* the phenomena of puberty, including the appearance of menstruation, are absent. We have already discussed delayed puberty, so shall not do more than mention it here.

Primary Permanent Amenorrhoea

A. Local Causes.—These are related to errors of development. It is impossible in the present state of our knowledge always to state definitely whether these conditions be due to primary local derangements¹ or to general disturbances in the organs of internal secretion,² acting locally, although in some cases the evidence may be reasonably clear. The structural anomalies to be mentioned will not be discussed here as such, since we are only dealing with disorders of function.

I. Abnormalities affecting the Ovaries.—(a) *Absence of Ovaries.*—This is apparently an extraordinarily rare condition, if, indeed, it ever occurs.³ Many individuals exist who are women in every particular except for the presence of testes instead of ovaries, but these people are considered men not women, since it has been the custom to base our declaration of the sex of any person upon the structure of the gonads.

(b) *Imperfect development of ovaries* is not recognized as a common condition. When observed there are usually deviations from the normal descent of the organs. In some cases the ovaries remain undescended in the neighbourhood of the kidneys, where they are originally developed; in others they descend into the inguinal regions, lying at the internal abdominal ring or within the inguinal canal. In such circumstances the genital tract is usually imperfectly developed as well; but the point we are concerned with for the moment is that the ovaries themselves may be underdeveloped—although more often they are not—and, therefore, can have no influence over the rest of the system in regard to the genital functions. It is possible that this condition is commoner than is generally supposed, and it may be the essential cause

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1909, vol. ii. p. 311.

² W. Blair Bell, *ibid.*, 1913, vol. vii. p. 47; Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. pp. 809, 937.

³ See also Article on Malformations (p. 222).—EDITORS.

in many cases of primary amenorrhoea, for it must be only occasionally that post-mortem examinations are performed in these circumstances, and even then the genital organs are probably often not examined.

(c) *Disease of the ovaries* may occur before puberty. We need not consider malignant growths, because they are nearly always rapidly fatal if they be not successfully removed. Sometimes, however, extensive cystic degeneration has been found, which has necessitated removal. It is often questionable whether menstruation would supervene in the ordinary way with these lesions even if the ovaries were not removed. It must not be forgotten, however, that it is more common for tumours of the ovary to be associated with precocious menstruation (*q.v.*) than with the reverse condition of amenorrhoea.

Tuberculosis of the tubes and ovaries in childhood is occasionally responsible for a persistent infantile condition of the organs, which, of course, leads to permanent amenorrhoea; and infection with gonococcus and bacillus coli (appendicitis) before puberty may also lead to a similar state of affairs.

II. *Abnormalities affecting the Uterus.*—(a) *Absence of Uterus.*—This condition is somewhat rare, although the apparent absence is not uncommon.

(b) *Rudimentary uterus* is the term applied to the condition of under-development which permanently precludes all possibility of further development. It is an anomaly associated with foetal life.

(c) *Other malformations of the uterus* which produce permanent amenorrhoea are those associated with imperfect formation of the uterus owing to the failure of the Müllerian ducts to unite in the normal fashion. The ununited uterine bodies are sometimes widely separated and consequently are rudimentary. We have removed the two uterine bodies from opposite inguinal hernia sacs.¹ It is only when the separate bodies come into pelvic relationship that a functional uterus didelphys can be formed.

(d) *Diseases of the Uterus.*—Tuberculosis of the uterus in childhood may so damage this organ that primary permanent amenorrhoea necessarily follows. We have seen such a case with caseous masses in the uterus of a woman of about thirty years of age. So, too, with gonococcal vulvo-vaginitis the organisms may ascend to the uterus and produce permanent lesions in this organ, and thus prevent the normal development.

B. General Causes.—Permanent primary amenorrhoea resulting from general disturbances is, so far as we know, only associated with congenital diseases of the endocritic organs. We have already discussed absence of puberty with permanent

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and. Gyn. Sect.)*, 1909, vol. ii. p. 311.

infantilism, and its relation to disturbances of the internal secretions, so there is no reason further to pursue the subject in regard to one of the phenomena—amenorrhoea—associated with that state. But we must reiterate what we said just now about the possibility of many maldevelopments of the uterus, especially rudimentary conditions, being due to foetal anomalies in the development or function of certain of the endocritic glands. Likewise, minor states of hypothyroidism so often seen in fat, stupid girls, which do not amount to cretinism, in which disease there is an absence of the thyroid, may cause so great a degree of secondary under-development of the uterus at puberty that the condition is permanent. So, too, with congenital hypopituitarism we have on more than one occasion seen an extreme degree of uterine under-development.

Much research, experimental and clinical, remains to be carried out on this important aspect of sexual inactivity.

Primary Curable (Temporary) Amenorrhoea

This condition may also be due to both local and general causes. Frequently they overlap; that is to say, the local condition may be secondary to the general.

As we have already indicated, the characteristics of puberty may be well developed, with the exception of the menstrual phenomena which remain in abeyance.

A. Local Causes.—I. *Hypo-oöphorism*.—This term implies insufficiency of ovarian secretion or secretions, which is a not infrequent cause of the delayed onset of regular menstruation. Experimental evidence has shown that the internal secretion of the ovary (probably derived from the interstitial cells) maintains the nutrition of the musculature of the uterus; for after oöphorectomy the muscle fibres undergo atrophy sooner than the endometrium.¹ It is possible that this atrophy is a disuse atrophy; that is to say, in the absence of contractions at regular intervals (monthly, in the human subject) the muscle fibres atrophy. Our own observations on rabbits showed that during the non-breeding season the uterus atrophied from want of use; ¹ consequently it is probable that variations in ovarian activity are responsible for the condition of the uterus.

It is not uncommon at the onset of menstruation for the menstrual periods to be variable, until the ovaries and uterus are fully developed functionally; and, as already stated, any delay in the second stage in the development of the ovary may cause primary amenorrhoea of a temporary character, although puberty is otherwise established.

Clinical observation gives us a useful guide in the treatment of this condition.

¹ W. Blair Bell and P. Hick, *Brit. Med. Journ.*, 1909, vol. i. p. 655.

With insufficiency of the ovarian secretion about puberty it is usual to observe some enlargement of the thyroid, and this, as we have seen, is usually periodic. The administration, therefore, of thyroid extract alone, or, better, in combination with ovarian extract as a rule brings about regular menstruation within a short time.

II. *Incomplete Development of the Uterus*.—As with some of those conditions of the uterus already discussed in regard to permanent amenorrhoea, the complete functional development of the structurally normal uterus is largely dependent upon the internal secretions.

B. General Conditions.—We have already discussed insufficiency of ovarian secretion, and must, therefore, now consider insufficiency of the other organs of internal secretion under the heading of general conditions which produce temporary primary amenorrhoea.

I. *Insufficiency of the Internal Secretions*.—With regard to these it is unnecessary to reiterate what has already been said in connexion with permanent primary amenorrhoea; for lesser degrees of insufficiency than those producing permanent cessation of menstruation may give rise to temporary primary amenorrhoea. In these circumstances insufficiency of the thyroid or pituitary is acquired, in the sense that these organs have lagged behind in the general development of the body, or, possibly, because their energies have been temporarily weakened owing to the demand made upon them during the process of building up the framework. Underlying the results which ensue are very interesting chemical problems upon which we shall touch but lightly.

Clinical observation has taught us that it is not usually the small, spare children who suffer from delay in the onset of menstruation, but the tall, adipose girls—a type similar to that we should expect to see if the subject had been castrated in early life. From this it is clear that the ovaries have not been activated at the normal time; if they had been, the rate of growth would have been checked, as usually happens when the onset of menstruation is early. But it must not be thought that it is this lack of development of the ovaries alone which leads to the final result. Recent investigations have proved the interdependence of the gonads and other organs of internal secretion, and have shown that the secretion from one organ of internal secretion may supplement or restrain the metabolic effects of the secretion from one of the others.¹

So it is that while these organs—the pituitary, suprarenals, thyroid and thymus—are promoting and controlling the somatic growth of the individual, the

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47; Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. pp. 809, 937.

sexual organs and sexual characteristics to some extent remain in abeyance. The chemical necessities of the situation lie behind the activities of the internal secretions ; for example, the woman must lay down enormous quantities of calcium salts in the formation of her bones before she can afford to supply her foetus with it or pour it out in her milk. Yet there may come a time when this very conservation becomes a menace and the organs of internal secretion are temporarily exhausted.

It is often only by careful laboratory investigations concerning the metabolism, which cannot be detailed here, that we are able to learn which of the endocrine organs is most affected, or whether more than one is functionally insufficient. The treatment will, in these circumstances, consist in the administration of a substitution extract or of a combination of extracts ; and our efforts will only be successful if the onset of menstruation has not been too long delayed. It is usually impossible to establish permanent and normal menstruation subsequently to primary amenorrhoea after the patient has reached the age of twenty years. It is, therefore, often advisable to waste no time, but to administer thyroid and pituitary extracts in combination with ovarian extract.

II. *Chlorosis*.—This form of primary anaemia, in which the haemoglobin content of the blood is much reduced, is a cause of primary amenorrhoea when the disease is established before the onset of menstruation. It is, however, very much commoner to see chlorosis in girls subsequently to puberty. We have, therefore, dealt with this condition more fully under the disorders of puberty (p. 305).

III. *Tuberculosis*, like chlorosis, is more liable to follow puberty than precede it, but the effects of the disease are more pronounced in regard to amenorrhoea when it occurs in young girls. Whether the lesions be situated in the lungs or joints the result is the same. There is a drain on the reparative resources of the individual, and this frequently prevents the onset of menstruation. So long as the genitalia are not involved in the disease and a cure is effected, menstruation may eventually be established, if too many years have not elapsed since the age at which puberty should have been fully developed.

IV. *Unsuitable Environment*.—By 'unsuitable environment' we mean to imply that environment which comprises bad feeding, bad air, insufficient exercise, too much muscular exertion under unsuitable conditions, or the deprivation of masculine society.

We need not go into these matters at any length for they have already been discussed. In many cases the unhygienic conditions in manufacturing towns are mitigated by the sexual freedom enjoyed. We know of no statistics concerning

girls brought up in convents, whose minds are taught to shun sex questions, but we have little doubt that the human female does not differ from females among the lower animals whose sexual functions are largely influenced by the proximity of the male.¹

Secondary Amenorrhoea.—By secondary or acquired amenorrhoea we imply the cessation of the menstrual function which has already been established.

Secondary amenorrhoea may be due to the physiological conditions associated with pregnancy, lactation and the menopause, or may follow pathological lesions of either a local or general character. Secondary amenorrhoea may be permanent or temporary, but we shall not discuss separately these two degrees, beyond stating that the permanent variety necessarily follows the menopause, the destruction or removal of the essential genital organs, and serious diseases of the general system which lead to atrophy of the ovaries and uterus.

Physiological Amenorrhoea

This is, of course, temporary so far as pregnancy and lactation are concerned, and permanent at the menopause. On the occurrence of conception menstruation normally ceases; and it is from this suppression of the menses that the period of pregnancy is commonly estimated. It would serve no useful purpose here to discuss in detail the reasons why the suppression occurs; it is probably dependent on changes both in the uterus and ovaries, and in the general metabolism. Sometimes menstruation takes place during the first three months of pregnancy, or when there is a second uterine cavity; at the same time it must be remembered that amenorrhoea usually co-exists with ectopic gestations, and even with pregnancy in one horn of a uterus didelphys or bicornis when the two uterine bodies are equally developed. Amenorrhoea, therefore, is not essentially due to the presence of a foetus in the uterus, but, rather, to some inhibitory effect in the organism generally, which is designed to meet the needs of the new situation.

In the same way during lactation it is usual for the menstrual function to be in abeyance, at any rate for many months. There is certainly no local condition in the genitalia specially responsible for the amenorrhoea of lactation; indeed, it is not at all uncommon for conception to occur before the menses have recommenced. As we have pointed out elsewhere on many occasions, the cessation of menstruation is probably due to the large excretion of calcium salts in the milk, and this renders less likely the occurrence of menstruation which is also concerned in the excretion of these salts. It has not been definitely proved that the milk deteriorates

¹ F. H. A. Marshall, *The Physiology of Reproduction*, 1910, p. 154.

in the presence of menstruation, but there is no doubt that women are frequently physically incapable of supporting the strain of both processes. We shall have more to say on this point when discussing menorrhagia.

With regard to amenorrhoea at the menopause, it is perfectly normal that there should be periods of amenorrhoea alternating at first with menstruation, and eventually becoming absolute. This subject will come under our notice again when we consider the menopause.

Pathological Secondary Amenorrhoea

A. Local Causes.—I. Lesions or Removal of the Ovaries.—It is but rarely that disease of the ovaries leads to amenorrhoea; as a rule, if there be any change in the character of the menstrual function it is of the nature of menorrhagia. If, however, the disease be so extensive as entirely to destroy the ovarian tissue then permanent amenorrhoea will supervene. These lesions are usually malignant in nature, but occasionally extensive infections lead to atrophy or destruction of the ovaries and to the cessation of menstruation.

The removal of all ovarian tissue leads to atrophy of the uterus, as we have already pointed out, and necessarily, therefore, to permanent amenorrhoea. The statement has been made by Halliday Croom¹ that 60 per cent of his cases menstruated subsequently to the removal of both ovaries—20 per cent regularly and the rest irregularly. It is usually held that complete removal of both ovaries leads to atrophy of the uterus and to the cessation of menstruation. This is certainly always so in animals, and usually so in the human subject. Indeed, the only question worthy of serious consideration is whether the other internal secretions can replace the ovarian. We know that the uterus atrophies after removal of the thyroid alone in animals, just as it does after removal of the ovaries.² And Cushing has shown that uterine atrophy also occurs after removal of the anterior lobe of the pituitary.³ It might be thought, therefore, that the function of menstruation should be maintained in the absence of ovaries. This is extremely unlikely, for we know that in regard to the genital functions the endocritic organs form a chain of which the most important link is the ovary. It is hardly possible that we shall ever be able to substitute entirely and with certainty the natural product. We have discussed this question elsewhere.⁴

Again, constitutional disease, as we shall see presently, may cause the secretions

¹ J. Halliday Croom, *System of Gynaecology*, edited by Allbutt, Playfair and Eden, 1906, p. 82.

² W. Blair Bell, Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. pp. 809, 937.

³ Harvey Cushing, *The Pituitary Body and its Disorders*, 1912.

⁴ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47.

of the ovary to become decreased, and in these circumstances scanty menstruation or amenorrhoea may ensue.

It must also be mentioned here that the external application of X-rays in the ovarian regions may, by destroying the secretory cells of the ovaries, lead to permanent amenorrhoea.¹

II. *Removal or Lesions of the Uterus.*—(a) *Removal* of the uterus entirely, or below the level of the internal os, almost always leads to amenorrhoea. A few cases have been recorded in which menstruation occurred from the cervical canal after removal of the body of the uterus (supravaginal hysterectomy). We ourselves met with a case of this description recently, in which menorrhagia occurred from a small stump of cervix half an inch in length after we had removed the body of the uterus; ultimately it was necessary to remove the cervix also. In some of the cases recorded it is probable that the amputation may have been at a higher level than the internal os, as may easily happen when the uterus is elongated by fibromyomatous growths. Histological examination of the cervix after removal alone proves definitely whether there be any but cervical tissue present in the stump, from which bleeding may occur.

Whenever possible in women under forty years of age a small portion of endometrium should be preserved when supravaginal hysterectomy is performed, in order to ensure future menstruation; but it is not always easy to know just how much to leave when the cervix is dilated. We mention this to point out the possibility of faulty observation when menstruation is stated to have occurred from the cervix in these circumstances.

(b) *Destructive lesions* of the uterus producing amenorrhoea are limited to severe infections, which may cause complete fibrosis of the lining membrane, and injuries, such as those produced by atmokausis, which are sufficient to cause permanent destruction of the endometrium.

(c) *Superinvolution* of the uterus following parturition, or more rarely abortion, is not so rare as is generally believed; about a dozen cases have come under our own observation. In this condition involution is carried beyond the normal extent, and atrophy of the uterus supervenes. Occasionally, in addition to amenorrhoea, the patient complains of other symptoms of the menopause, such as vague intestinal discomforts and slight flushings (see p. 381). The pathology of this condition is not understood. It is, however, remarkable how frequently post-partum haemorrhage has occurred in the previous history of these cases. We have seen superinvolution when the patient has not nursed, consequently it cannot be a 'lactation atrophy,'

¹ See also Article on Radio-Therapeutics (Vol. III. p. 807).—EDITORS.

as some describe. However, this is not the place to discuss the subject apart from its bearing on amenorrhoea.¹

The treatment is most unsatisfactory. Intra-uterine stem pessaries are said to be beneficial by promoting contractions of the uterus,² but we know of no series of cases in which this method of treatment has been proved to be of value.

If, as is probable, the lesion follows some disturbance in the internal secretory system, then treatment by organic extracts seems indicated *if the case be seen early enough*. In one case of eleven months' duration which was associated with Graves' disease, we succeeded with pituitary extract in bringing about a restoration of the function of menstruation and a return to the normal size of the uterus, simultaneously with a great improvement in the disease of the thyroid.³

B. General Causes.—**I. Anaemia.**—Both the primary form of anaemia known as chlorosis and secondary anaemia, other than that produced by menorrhagia, may cause temporary secondary amenorrhoea. In young women, especially those of the working classes, chlorosis is a most common disease, and when it is at all marked amenorrhoea is a constant symptom. Constipation is usually associated with chlorosis, and it has been stated by some that this disease results from copraemia. Others think that the condition of the genital functions is responsible for the anaemia. Be this as it may, there is no doubt that both the chlorosis and amenorrhoea can be quickly cured by iron, if it be administered in sufficient quantities. The compounds of iron usually prescribed are very slow in their action and rarely entirely successful. The treatment with *ferrum redactum* already described (p. 305) has given excellent results in our hands. Cases of secondary anaemia with amenorrhoea may be treated on similar lines.

II. Nervous Disturbances.—Secondary amenorrhoea from nervous disturbances is nearly always temporary. Psychological derangements are more prone to interfere with menstruation than are organic nerve lesions. Of insanities, melancholia is frequently associated with the cessation of the menstrual function or with periods of amenorrhoea. Should the patient recover, an important sign of improvement is the returning regularity of menstruation.⁴ Shock and fright, or other severe emotions, may lead to temporary amenorrhoea; but it is rare in these circumstances for the patient to miss more than one or two periods.

Post-nuptial amenorrhoea is not uncommonly seen: the absence of menstruation

¹ This subject is more fully discussed in the Article on Morbid Involution (Vol. II. p. 153).—EDITORS.

² R. L. Dickinson and W. S. Smith, *Amer. Journ. Obstet.*, 1913, vol. lxxviii. p. 686.

³ W. Blair Bell, *Trans. North Eng. Gyn. Soc.*, 1913, p. 36.

⁴ C. T. Ewart and others, "Discussion of Amenorrhoeal Insanity," *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1911, vol. v. p. 81.

may date from marriage, or not until a month or two later—the former being the commoner. Often it is difficult to define the psychical condition which is responsible for it: sometimes after marriage the mental attitude of the patient is powerfully altered in regard to sexual matters, and there is sexual fright or the expectancy of pregnancy; or there may be a quiet and indefinite disturbance in the whole nervous system of which the only evidence is the cessation of menstruation. Again, after illicit intercourse the fear of pregnancy may lead to temporary amenorrhoea. Likewise, with the condition known as ‘*pseudocyesis*’ there is always amenorrhoea. In this state the patient satisfies her desire for motherhood by imagining she is pregnant; and among the other well-known symptoms of her condition is the interruption of menstruation, without which the patient could not even delude herself.

In the case of no other organic function is the power of the mind better shown than in its influence over menstruation.

III. *Diseases of the Endocritic Organs.*—We have already seen how intimately connected with the development of the menstrual function are the internal secretions; and we have referred, under the local phenomena, to hypo-oöphorism as a cause of temporary secondary amenorrhoea.

So far as our present knowledge is concerned we are much more familiar clinically with insufficiency of the thyroid secretion than we are with that of the pituitary, although in the last few years additional knowledge in regard to the latter has been very interesting and illuminating. The commonest form of thyroid insufficiency in adults, previously healthy, is that associated with the disease known as myxoedema; and it is one of the greatest triumphs of modern medicine that all the symptoms of this disease—the mental depression, the mucoid oedema and the amenorrhoea—can be swept aside and kept in abeyance by the administration of thyroid extract. We have known a patient with myxoedema who, after a few months’ treatment, menstruated regularly and eventually conceived. Such cases must now be quite common.

It is an interesting question, which has yet to be definitely decided, to what extent the uterus atrophies in myxoedema. It is possible that were a case to be of long duration before treatment was undertaken, the uterus might atrophy beyond the possibility of subsequent improvement. The temporary or permanent character of the amenorrhoea in these circumstances is dependent, therefore, on whether the patient come under observation and treatment at an early stage of her disease.

It has long been known that with lesions in the anterior lobe of the pituitary amenorrhoea inevitably supervenes, and recent work has placed this knowledge on

a sound basis.¹ As already mentioned, acromegaly may produce in women masculine characteristics with amenorrhoea.² This amenorrhoea is due to the development of masculinity, and such a phenomenon is sufficient to explain many apparent paradoxes in regard to sex characteristics and functions, and their relation to the internal secretions. It is clear, then, that with acromegaly, in which there is an excess of secretion from the anterior lobe, we get amenorrhoea because of the masculinity produced; and with the opposite condition, known as *dystrophia adiposo-genitalis*, which according to Harvey Cushing¹ follows acromegaly, we see amenorrhoea because there is not enough of the internal secretion to keep the genitalia active. This syndrome of Frölich—*dystrophia adiposo-genitalis*—may also result from tumours at the base of the brain pressing on the pituitary, or from intrinsic growths or cysts which destroy the substance of the anterior lobe. Cushing and others have successfully operated on some of these cases, especially when the condition has been due to cyst formation. The results subsequently to operation have been fairly good: men previously impotent have become potent, so there is no reason why women, also, might not be successfully treated. In the case of one man who was almost blind from pressure on the optic nerves and was absolutely impotent, excellent results were obtained by the administration of anterior lobe extract, at our suggestion: not only did potency return, but the patient's wife subsequently gave birth to a child. But, as with myxoedema, it is extremely likely that too long continued inactivity, with atrophy of the uterus, would lead to an incurable state of affairs.

Suprarenal lesions of the nature of hyperplasia or neoplasia in the cortex, which produce signs of masculinity, also produce amenorrhoea, and, owing to the incurability of the disease in the majority of cases, may result in the menstrual suppression becoming permanent.

Finally, in true hermaphroditism, as already mentioned, with the development of the masculine characteristics previously existing menstruation may be suppressed.

Before leaving the subject of disorders of the endocritic organs we should like to express our belief that in the future many conditions of these organs giving rise to excess and insufficiency will be treated with antagonistic or supplementary extracts of the other organs of internal secretion. We already have evidence of the benefit of this form of treatment in the use of antagonistic extracts in the treatment of osteomalacia (? hyperoöphorism) and Graves' disease (hyperthyroidism), by suprarenal and pituitary extracts respectively; and of the advantage of a supplementary

¹ Harvey Cushing, *The Pituitary Body and its Disorders*, 1912; W. Blair Bell, *The Sex Complex*, 1916.

² W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii, p. 47.

extract in the use of thyroid extract for amenorrhoea due to hypo-öophorism. There is, therefore, no longer any reason for the scepticism exhibited by many who from imperfect observation have failed to realize or understand the importance of this new aspect of our subject.

IV. *Debilitating Diseases.*—All continued fevers, such as typhoid, and wasting diseases, such as tuberculosis, may be associated with amenorrhoea. We believe that this state of affairs is largely due to the great demand of the tissues for calcium salts in the processes of repair. This is especially well seen in tuberculosis, in which disease the extensive calcification of affected tissues is associated in many cases with recovery. There is, moreover, a drain on the resources of the organism in regard to other chemical substances, such as the carbohydrates which are so important in maintaining the standard of alkalinity of the blood and tissues. The nervous system too, is depressed, and the muscles—involuntary and voluntary—are less active; probably this is to some extent dependent on the depletion of calcium salts, as is, also, the lowered blood pressure.

As a rule, secondary amenorrhoea due to debilitating diseases is of a temporary character, and with the recovery of the patient menstruation becomes re-established, consequently no treatment specially directed towards the menstrual suppression is required. If there be undue delay in the process of recovery, calcium salts and combinations of extracts of the pituitary, thyroid, ovary and suprarenals (poly-glandular extract) may be administered. We have under treatment at the present time a lady who consulted us because she had only menstruated for a few hours every four weeks since an attack of typhoid fever six years previously. Before her illness she had menstruated normally.

V. *Heart Disease.*—In those cases of heart disease, apart from mitral stenosis, in which there is any derangement of menstruation, Gow¹ has conclusively shown that amenorrhoea or scanty menstruation are the disorders which invariably occur. Usually, however, there is no disturbance of the menstrual function in these circumstances until the last stages of the disease.

VI. *Exposure to Cold.*—Whether this be the result of a sudden chill or the change from a hot climate to a cold one the effect is the same: amenorrhoea may occur. With regard to the former it is usually of a more temporary character than the latter; usually, however, neither is of long duration. Sudden chills from sea-bathing, taking cold baths, getting wet and cold while out walking, hunting or following the daily occupation—especially when acquired just before the menstrual period—not infrequently lead to suppression of the ensuing menstruation. What the exact

¹ W. J. Gow, *Trans. Obstet. Soc.*, 1894, vol. xxxvi. p. 126.

pathological effect a chill has on the menses has never been definitely determined ; probably a vasomotor reflex is produced, and this leads to retrograde changes in the premenstrual endometrium comparable with the effect on nose-bleeding of a cold sponge applied to the back of the neck.

The treatment of the menstrual suppression, which is often accompanied by pelvic pain, consists in the patient taking very hot baths, applying hot bottles to the abdomen, and in the administration of stimulants, such as spiritus etheris nitrosi. It is better not to order ordinary alcoholic drinks, lest the patient get into the habit of taking them.

Change of climate produces a definite effect on the inhabitants of tropical countries when they migrate to colder latitudes, and stay there. So, too, an English-woman who has been in India for some years may suffer with amenorrhoea on her return to this country, until she has become acclimatized. It is well known, also, that women in very cold climates, such as Greenland, menstruate very feebly and only during the warmer months, while women in tropical countries nearly always menstruate profusely.

VII. *Unsuitable Environment*.—If a woman who has always led an easy and luxurious life suddenly has to earn her own living, and perhaps exist in uncomfortable surroundings and on a scanty diet, she frequently suffers with amenorrhoea or scanty menstruation. The etiological factors are, no doubt, partly mental and partly metabolic. As a rule, the amenorrhoea is only temporary, for as the woman gets more used to her surroundings menstruation will recommence and continue normally, if the conditions of her life be not too hard. So, too, it has been shown that the girls in the senior classes at large schools during the term very frequently suffer with amenorrhoea which disappears during the holidays.¹

VIII. *Drug Habits*.—Morphia and cocaine may lead to the suppression of the menses if taken habitually over a considerable length of time. In some cases the habit has been discovered owing to the amenorrhoea about which the patient has sought advice.

Scanty Menstruation

Scanty menstruation implies either that menstruation has always been scanty (primary scanty menstruation) when compared with an average minimum normal standard ; or that menstruation in any given case is considerably less than is normal to the particular individual (secondary scanty menstruation).

Primary Scanty Menstruation.—We have already seen that primary permanent amenorrhoea and primary temporary amenorrhoea are for the most part dependent

¹ G. A. Cardew, Discussion, Brit. Med. Assoc., *Brit. Med. Journ.*, 1900, vol. ii. p. 792.

on somewhat similar causes, subject to the time of action and degree of intensity. Thus the development of the uterus may be permanently arrested or only temporarily delayed. And so it is with primary scanty menstruation, for this is a condition which frequently follows delay in the onset of the function due to under-development of the uterus; or it may be a compromise between normal menstruation and amenorrhoea due to some general disturbance, such as chlorosis or unhygienic surroundings. The treatment of primary scanty menstruation is, therefore, identical with that of primary temporary amenorrhoea.

It is, however, important to remember that the prognosis in regard to primary scanty menstruation depends on whether it be due to local or general disturbances. When dependent on local causes the prognosis is bad with respect to further improvement: the patient may be sterile, and an early menopause usually supervenes. Women with primary scanty menstruation are often unemotional, languid and without sexual fervour, and are generally but little affected by the menopause, whether it be natural or artificial.

Secondary Scanty Menstruation.—When menstruation becomes scanty after the flow has been normally established, the causation depends to a considerable extent on those factors, already discussed, which produce secondary amenorrhoea. Secondary scanty menstruation is, therefore, a condition which varies between the previously normal condition and amenorrhoea. For instance, with incipient myxoedema the menstrual discharge may become scanty before disappearing, and if treatment be adopted the thyroid insufficiency and consequent menstrual symptoms may be relieved.

Scanty menstruation, therefore, whether primary or secondary, is best considered in connexion with amenorrhoea, to which it is so closely related. There are, however, one or two points with regard to the local causes of secondary scanty menstruation which call for special comment, for they concern recently evolved surgical procedures.

We allude, of course, to conservative operations on the ovaries and uterus. If the whole of one ovary and part of the other be removed there may be a temporary cessation of menstruation followed by scanty menstruation. Likewise, in high supravaginal amputations of the uterus when some of the endometrium is left the patient tends to menstruate scantily: there is at each period a slight discharge for perhaps two days. Other operations which may lead to scanty menstruation are performed with that object in view: to mitigate previously profuse menstruation. Utericuloplasty¹ and acrohystero-salpingectomy² may both lead to scanty menstrea-

¹ Victor Bonney, *Lancet*, 1911, vol. i. p. 1266.

² W. Blair Bell, *Surg. Gyn. and Obstet.*, 1914, vol. xviii. p. 634.

tion, since it is obviously impossible always correctly to gauge the amount of uterus which should be left in order to produce menstruation of normal duration and quantity.

Menorrhagia, Metrostaxis and Epimenorrhoea

In considering excessive menstruation and intermenstrual haemorrhage we shall not be concerned with the haemorrhages connected with intra-uterine or extra-uterine pregnancies.

'Menorrhagia' implies excessive menstrual haemorrhage either in regard to duration or quantity. At puberty this excess, in any patient, is gauged by an average standard; but, subsequently, by the previous menstrual history of the patient concerned. Thus, many women normally menstruate freely for five or six days, others moderately for three days. If, therefore, one of the latter type at a later period were to menstruate freely for six days, we should not consider this to be normal in comparison with her previous standard. It will be evident, then, that within certain limits there are no fixed standards in regard to the quantity and duration of the menstrual flow: each woman has a standard of her own, with which alterations must be compared.

'Metrostaxis' means haemorrhage from the uterus apart from that associated with the menstrual flow. It has been the custom by some to limit the use of this term to haemorrhage from the uterus before puberty and after the menopause;¹ but we think such a special and limited use of this word is inadvisable. We prefer to include in 'metrostaxis' all haemorrhages not of menstrual origin.

'Metrorrhagia' is a term which would be better dropped altogether; its etymology is poor, and intermenstrual bleeding, which it is made to imply, should often be included in the word metrostaxis. *Too frequent menstruation*, which some include in this term, is worthy of a distinctive name and should not be confused with intermenstrual bleeding.

Epimenorrhoea.—A woman who has menstruated normally for four days every twenty-eight ($\frac{4}{28}$) may subsequently menstruate for four days every fourteen ($\frac{4}{14}$). This phenomenon is identified by none of the terms alluded to above. Hitherto we have ourselves alluded to the condition as "too frequent menstruation," but this is clumsy and cumbersome; consequently we propose to use the terms '*epimenorrhoea*' and '*epimenorrhoeal*'; and, when the epimenorrhoeal discharge is too profuse, we intend to allude to the condition as '*epimenorrhagia*.' For pathological menstrual excesses we shall, therefore, employ the terms 'menorrhagia,' 'epimenorrhoea' and

¹ T. G. Stevens, *Diseases of Women*, 1912, p. 89.

'epimenorrhagia,' and for uterine bleeding apart from menstruation, 'metrostaxis.' We shall drop altogether the term 'metrorrhagia.' Very frequently, of course, all these forms of bleeding from the uterus occur in the same patient from the same cause. It is, therefore, often impossible to distinguish at first where one form of menstrual excess begins and another ends; or what is menstrual excess, and what metrostaxis, for the bleeding may even be continuous. As a rule, however, when the cause is a local lesion it is of no special clinical importance to make any distinction, for removal of the cause will lead to the restoration of the normal function; but when the cause is a general one a distinction may be of more importance.

We shall most conveniently, then, consider all forms of uterine haemorrhage together, indicating the specific variety or varieties of haemorrhage met with.

The causes are general and local, and in making a diagnosis of the cause of menorrhagia, epimenorrhoea or metrostaxis, we would point out that for obvious reasons *in young unmarried women the cause is usually general, while in older and married women the cause is most frequently a local one.*

A. General Causes.—**I. Blood Diseases.**—Women with purpura haemorrhagica, scurvy or pernicious anaemia, and females of haemophilic families may all suffer with menorrhagia, epimenorrhoea and metrostaxis. These diseases, however, give rise to haemorrhages elsewhere, but the uterine haemorrhage may be the most marked because of the natural tendency of the uterus to bleed.

(a) *Haemophilia* is a disease which is supposed to be transmitted to the males in haemophilic families through the females, and not to affect the women themselves. How far this is actually borne out by general experience we do not know, but certainly we have seen the females of haemophilic families suffer with severe menorrhagia. In one case there were also frequent attacks of nose-bleeding, and on several occasions vesical haemorrhage. So far as we have observed metrostaxis and epimenorrhoea are exceptional. We know little of the pathology of this condition, but the lowered coagulability of the blood is probably due to some irregularity in the formation of fibrin ferment. These cases are best treated with normal horse serum (10 c.c.) and calcium lactate (gr. xxx.) by the mouth once a day.

(b) *Scurvy* in adults is such a rare disease in the present day that menorrhagia and metrostaxis from this cause must be almost unknown in this country.

(c) *Purpura haemorrhagica* occurs chiefly in young and delicate girls. The etiology and pathology of the disease are unknown, although it is believed to be toxic in origin. There are sudden haemorrhages under the skin, and sometimes from the mucous surfaces, of which the endometrium is one. Metrostaxis is the

only variety of haemorrhage that occurs in this condition. Like haemophilia, in the present state of our knowledge, this disease is best treated with horse serum and calcium lactate.

(d) *Pernicious anaemia* is comparatively a rare disease in women, but the tendency to haemorrhage may be evident in attacks of metrostaxis and menorrhagia.

(e) *Acute Fevers*.—Menorrhagia of toxic origin is not uncommon at the onset of an acute fever with a high temperature, especially if this coincide with a menstrual period. Pneumonia and typhoid fever are probably the conditions in which menorrhagia is most frequently observed. Metrostaxis and epimenorrhoea are sometimes seen. Treatment is not often demanded, for as a rule the bleeding in these circumstances is beneficial rather than the reverse.

II. *Diseases affecting the Circulatory System*.—(a) *Obstruction and 'back pressure' in the vena cava* from any cause lead to venous engorgement of the ovarian and uterine veins; and as a result there may be prolongation of the menstrual flow, and, also, an increase in the quantity—menorrhagia. Sampson¹ has shown that menstrual blood comes from the venules, consequently any 'back pressure' increases the engorgement. Metrostaxis and epimenorrhoea are infrequent.

(b) *Mitral stenosis* may be associated with menorrhagia. This lesion of the heart is usually a sequel to rheumatism in young girls. Therefore, in looking for the cause of menorrhagia in young women, the heart should always be examined. We were once consulted on the same day by two sisters, aged eighteen and sixteen respectively, both of whom were suffering with menorrhagia from mitral stenosis. Metrostaxis and epimenorrhoea are rarely seen with this disease. Gow,² who made a study of the subject, found that menorrhagia only occurred in about one-fifth of the cases observed; in the majority menstruation was unaltered, and in about one-fifth there was amenorrhoea. The treatment of menorrhagia resulting from a lesion in the circulatory system depends to a large extent on the treatment of the primary disease. Rest in bed during menstruation is always essential when there is mitral stenosis, and we have found that the menorrhagia can be very satisfactorily controlled by the administration of calcium lactate. This result probably indicates that the bleeding is due to loss of tone in the involuntary muscle, which is only to be expected in these delicate girls.

III. *Chronic Infections*.—Chronic debilitating diseases, such as tuberculosis and septic infections, are occasionally associated with menorrhagia. This is no doubt due to the loss of muscular tone, possibly brought about by a continual drain on the

¹ J. A. Sampson, *Surg. Gyn. and Obstet.*, 1913, vol. xvi. p. 144.

² W. J. Gow, *Trans. Obstet. Soc.*, 1894, vol. xxxvi. p. 126.

calcium salts. Amenorrhoea, however, is much commoner than menorrhagia in these circumstances when the disease is advanced.

IV. *Diseases of the Kidney*.—Chronic nephritis, partly by raising the arterial tension and partly by giving rise to toxins in the blood, may give rise to menorrhagia, and even to metrostaxis, as a part of the haemorrhagic tendency seen in this disease.

V. *Disturbances of the Nervous System*.—(a) *Fright and shock* may cause metrostaxis. We were once consulted about a lady who witnessed a street accident in which a child was run over. Almost immediately there was a sudden severe haemorrhage from the uterus as a result of the mental apprehension. So, too, the shock and fright of an accident to a woman herself may give rise to metrostaxis.

(b) *Acute manias of the active type* are usually held to be responsible for the menorrhagia with which these patients may suffer. We think that a careful examination should always be made of the pelvic organs of lunatics suffering with menstrual anomalies, for it is quite possible that many mental derangements are, to some extent at least, dependent on diseases of the genitalia.

(c) *Sexual Excitement and Excess*.—We have pointed out elsewhere¹ that young women who are engaged to be married, or, in the lower classes, who indulge in the amorous flirtation known as ‘walking out,’ may suffer with menorrhagia and epimenorrhoea. The exciting situations and performances which may be associated with courtship, without full sexual gratification, are to be held responsible for the menstrual disturbances. These cases require no treatment. Absence of the fiancé or matrimony leads to a natural cure. Meanwhile, provided there is no excessive loss, the bleeding is probably not harmful.

Excessive sexual indulgence, which may lead to disturbances similar to those just described, does not appear to be common among normal women; and when menorrhagia is seen in a prostitute it is wise to exclude the possibility of infective lesions—though this can rarely be done—before attributing the cause to excessive venery, for prostitutes rarely desire or attempt to obtain satisfaction promiscuously.

VI. *Disorders of the Endocritic Organs*.—Of the ductless glands other than the ovaries the thyroid alone plays any part in increasing the menstrual flow and so leading to menorrhagia, epimenorrhoea and epimenorrhagia; for, as we have already shown, increase in function of the pituitary, suprarenal cortices and pineal leads to masculinity with amenorrhoea.

(a) *Hyperthyroidism* associated with menorrhagia at puberty we have already mentioned; hyperthyroidism at the menopause we shall describe later, but that occurring during adult life we are now concerned with. Excess of thyroid secretion

¹ W. Blair Bell, *Principles of Gynaecology*, 1910, p. 201.

causing menorrhagia occurs in the early stages of Graves' disease (exophthalmic goitre), and in less marked conditions which do not amount to exophthalmic goitre, but which, nevertheless, give rise to an increase in the secretion of thyroid above the needs of the metabolism.

Some gynaecologists¹ assert that Graves' disease and hyperthyroidism are associated with amenorrhoea. This is, we believe, not really the case. In the early stages of exophthalmic goitre excess of the menstrual function is not uncommon, but with the progress of the disease the ovarian secretion becomes decreased; and this ovarian insufficiency, the increasing debility of the patient and the excessive excretion of calcium salts in the urine and faeces which occurs in Graves' disease, all combine to cause menstruation to be in abeyance. In other words, it is probable that over-secretion of the thyroid, if not grossly pathological, at first augments ovarian activity and later replaces it in the general metabolism to so great an extent as to lead to the suppression of menstruation through ovarian insufficiency.

The treatment of menorrhagia due to hyperthyroidism consists in the treatment of the primary disease. Infundibulin and calcium lactate are most beneficial. In serious cases applications of the X-rays to the thyroid gland have given promising results.

(b) *Hypothyroidism*.—We can explain in a similar way why occasionally the onset of myxoedema, in which disease amenorrhoea is almost constant, is sometimes accompanied by menorrhagia: ² the disturbance of menstruation is due to increase in the ovarian activity to meet the deficiency of thyroid secretion.

It must, however, be pointed out that these are theoretical explanations, for we have no means of producing the exact lesions experimentally.

Hypothyroidism is, of course, treated with thyroid extract.

The contrary effects on menstruation of *apparently* similar diseases of the organs of internal secretion make it necessary for us to recognize that the only explanation lies in the fact that these diseases are not always similar in one fundamental respect: namely, in their relationship at any given time to the other organs of internal secretion, which may vary with the age and other peculiarities of the individual, and with her necessities of the moment.

(c) *Hyperoöphorism* causes menorrhagia, but we shall deal with this condition under the local causes.

VII. *Alcoholism*.—Chronic alcoholism probably gives rise to menorrhagia in two ways: firstly, by causing cirrhosis of the liver and 'back pressure,' and

¹ A. Donald, *Trans. North Eng. Gyn. Soc.*, 1913, p. 37.

² E. Hertoghe, *Practitioner*, 1914, vol. xciv, p. 26.

secondly, by producing a toxic fibrosis in the musculature of the uterus like that produced by infective toxæmias.

VIII. *Climatic Conditions*.—The menstrual discharge of Englishwomen usually becomes more profuse when they go to India and other hot climates; sometimes, indeed, menorrhagia is severe, and the patient becomes anaemic. As a rule, however, women in these circumstances say they feel better when the flow is great, and that they suffer when it is moderate in amount. The increase in the menstrual discharge is probably caused by want of muscular tone due to the atmospheric conditions.

IX. *Superlactation*.—We have often observed among the poorer classes, such as those who attend the out-patient departments of hospitals in large cities, that the prolonged lactation which they practise—sometimes in the hope of preventing conception, and at other times to save buying milk—may lead to menorrhagia and epimenorrhoea.

Many women who menstruate while they are nursing their babies suffer with these menstrual disturbances if lactation be continued for more than nine months, or, sometimes, for a shorter period. It appears probable that this is due to the prolonged drain of calcium salts in the milk. The treatment consists in weaning the baby and prescribing calcium lactate in large doses. With this simple treatment the headache, backache and lassitude vanish in a few days, and menstruation subsequently becomes normal.

B. *Local Causes*.—Haemorrhages from the uterus, with which we are concerned here, must be distinguished from haemorrhages from the vagina, vulva, bladder and rectum. It is sufficient to call attention to this point without going further into the subject; it is merely a matter of careful examination, especially at the time when the bleeding is in progress. Most of the local causes of uterine haemorrhage are capable of giving rise not only to menorrhagia, but also to epimenorrhoea and epimenorrhagia, and even to metrostaxis.

I. *Infections*.—Infections of the uterus, tubes, ovaries and pelvic peritoneum are very common causes of menorrhagia. Whitehouse¹ found that excessive menstruation occurred in 38 per cent of all cases of pelvic infection.

In young unmarried women tuberculous salpingitis or pelvic infection with appendicitis are the commonest varieties of lesion; while in married women gonococcal salpingitis, septic infection of the tubes after parturition or an abortion and pelvic infection with appendicitis are most often seen. In all ascending infections, in addition to the tubes, ovaries and pelvic peritoneum, the uterus must be infected, although owing to its extensive blood-supply this organ has greater powers of recovery

¹ B. Whitehouse, Hunterian Lecture, *Lancet*, 1914, vol. i. p. 951.

than the other structures. It is important, in this connexion, to note that menorrhagia is commoner with ascending infections than with descending or with blood-infections. In other words, infections of the uterus, whether chronic or acute, cause menorrhagia in a far larger percentage of cases than do infections of the tubes and ovaries alone.

This is a pathological point of considerable moment in determining the operative procedures necessary to effect a cure. Thus, in serious gonococcal infections it is often not enough to remove the tubes alone; and no scientific operator would remove both ovaries unless they were destroyed by abscesses, for the internal secretion of these organs is of great value, especially to young women.

Being struck with the frequent occurrence of menorrhagia subsequently to bilateral salpingectomy for ascending infections, we have for some time removed a wedge-shaped piece of the fundus uteri together with the tubes.¹ The most badly infected portion of the uterus is thus removed, and a moderate menorrhoea follows.

But besides infection of the uterus there are other causes of menorrhagia with pelvic infections: there is increased vascularity of the parts, and sometimes venous obstruction; and, also, the fact that the ovaries are frequently bound down in a mass of adhesions which prevents the normal discharge of ova, and leads to the formation of blood-cysts and cystic follicles. Increased vascularity and venous obstruction probably play a definite part in the result; but there is no doubt that the ovarian irritation which is produced by unruptured follicles when the ovary is buried in adhesions is chiefly responsible for the menorrhagia.

In addition to the direct results produced by infections which involve the ovaries, tubes and pelvic peritoneum as well as the uterus, there is the condition known as 'fibrosis uteri,' in which the uterus alone is affected. This condition is, we believe, always a sequel to chronic metritis, and is found in women over thirty-five years of age who have borne children.² Various views are held as to the pathology of this lesion, which is discussed fully elsewhere in this work (Vol. II. p. 117).

'Fibrosis uteri' is a somewhat rare but definite pathological lesion, although the causal factor is not always the same; and 'bleeding uteri' in which fibrotic changes are not found should not be classified with those which show fibrosis. There has been a disposition on the part of some pathologists and clinicians to seek for histological changes in the uterus in all cases of menorrhagia, epimenorrhoea or metrostaxis without macroscopic lesions. Papers have even been published³ on

¹ W. Blair Bell, *Surg. Gyn. and Obstet.*, 1914, vol. xviii. p. 634.

² W. Blair Bell, *Principles of Gynaecology*, 1910, p. 265.

³ Louise McIlroy, *Brit. Med. Journ.*, 1910, vol. ii. p. 1239 *et seq.*

cases of supposed 'fibrosis uteri' in which there was not the slightest clinical or histological evidence of that condition. Such a narrow and inaccurate outlook is bound to lead to disappointment and negative results. It is rare to see metrostaxis or epimenorrhoea from this cause alone, although the menorrhagia may be so protracted as to lead to almost continual bleeding. Usually no medicinal remedy is of any use in the most marked cases of 'fibrosis uteri.' Subtotal hysterectomy alone rescues the patient from serious ill-health.

II. *Chronic Subinvolution of the Uterus.*—This condition appears frequently to have been mistaken for 'fibrosis uteri.' The essential differences are: firstly, the uterine cavity is definitely enlarged with chronic subinvolution, and not at all, or very slightly, with 'fibrosis uteri'; secondly, histological examination in chronic subinvolution reveals no excess of fibrous tissue, but, rather, muscular hypertrophy with an excess of perivascular elastic tissue;¹ and thirdly, chronic subinvolution may be present at any age. With this condition there is menorrhagia. The treatment consists in curetting followed by a course of infundibulin. In obstinate cases electro-therapy should always be tried before the patient is submitted to hysterectomy.²

III. *New Growths and Retention Cysts.*—(a) *New growths and retention cysts in the uterus* are generally associated with uterine haemorrhage; when, however, there is no encroachment on the uterine cavity menstruation may be normal. Fibromyomata uteri and adenomyomata may give rise to all the varieties of haemorrhage mentioned. When the growth is not submucous, menorrhagia is usually the only alteration in the menstrual function, but when the tumour is submucous or polypoid in the uterine cavity then we generally see not only menorrhagia and epimenorrhoea, but sometimes metrostaxis as well.

With simple adenomatous changes in the endometrium menorrhagia may be seen, but if there be polypoid adenomata all the other forms of haemorrhage may occur.

With all innocent new growths of the endometrium and muscular walls of the uterus there is apt to be hypertrophy of the unaffected musculature, brought about by the frequent contractions which take place in it as attempts are made to expel the growth. This hypertrophy and frequency of contraction tend to increase the bleeding.

If malignant diseases attack the uterus before the menopause menorrhagia may be very severe; there is, also, in these circumstances nearly always metrostaxis as well. In carcinoma of the cervix found inoperable on opening the abdomen, we

¹ W. Fletcher Shaw, *Journ. Obstet. and Gyn. British Empire*, 1914, vol. xxvi. p. 73.

² See also Article on Chronic Metritis and Allied Conditions (Vol. II. p. 117).—EDITORS.

have, therefore, sometimes removed the ovaries, to check the excessive losses of blood which may occur at the menstrual periods.

Retention cysts of the endometrium, which are sometimes seen with fibromyomata¹ or in the hypertrophic form of adenomatous disease, and those arising in the muscular wall of the uterus from congenital relics may, also, cause menorrhagia.

(b) *New growths of the ovaries and tubes, and retention cysts in the ovary* not infrequently give rise to menorrhagia.

Sometimes we find that the ovaries in women suffering with menorrhagia are riddled with unruptured and cystic follicles. On such an ovary being cut through it resembles Gruyère cheese (Fig. 156). We have seen this condition especially well marked in married women separated from their husbands. Marshall,² in his valuable work on the physiology of reproduction, describes the evidence which has been obtained concerning the effect on the ovary of sexual abstinence in the lower animals during the rutting season. He shows that atresia, often with cystic degeneration of the Graafian follicles, invariably follows. We ourselves have seen cystic degeneration of the atretic follicles in does which had been kept in the neighbourhood of bucks, but were denied congress. It is believed, moreover, that in these animals rupture of the follicles occurs only during coitus.³ In women ovulation takes place without the stimulus of coitus; but it is quite possible that in a woman accustomed to marital life, deprivation of sexual connexion would, as suggested above, for mechanical reasons lead to atresia of the follicles with cystic degeneration, instead of regular ovulation with dehiscence. At the same time we do not for a moment wish to imply that there are not other causes, such as an abnormally dense tunica albuginea, by which, also, the condition may be produced.

With larger ovarian cysts—early adenomatous cysts—especially when they are bilateral, menorrhagia is not uncommon. Solid tumours of the ovary, whether innocent or malignant, occasionally cause menorrhagia, especially in the early stages

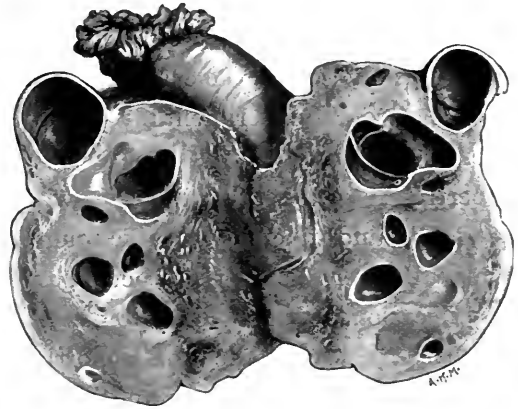


FIG. 156.—Ovary and Fallopian tube from a patient suffering with menorrhagia. The ovary is cut open to show the cystic follicles. ($\times \frac{1}{2}$.)

¹ H. A. Kelly and T. S. Cullen, *Myomata of the Uterus*, 1909, p. 323.

² F. H. A. Marshall, *The Physiology of Reproduction*, 1910, p. 154.

³ W. Heape, *Proc. Roy. Soc. Biol.*, 1905, vol. lxxvi, p. 260.

of growth. No doubt all these lesions give rise to ovarian irritation, possibly with hyperplasia.

(c) *Hyperplasia of the Ovaries*.—Interstitial hyperplasia of the ovaries gives rise to menorrhagia. Many clinicians, however, deny that hyperplasia, apart from compensatory hypertrophy, occurs; nevertheless, we have ample evidence that enlargements—other than growths and cyst formations of the ovaries—are not infrequent, and that they are associated with menorrhagia. In these ovaries there may be no cysts, but merely a general enlargement, with an increase in the number of interstitial cells. We first called attention to this condition some years ago,¹ and Whitehouse² has lately brought forward further confirmatory evidence.

It is reasonable to suppose, in spite of criticism to the contrary, that a multiplication of similar internal secretory cells leads to an increase in the amount of secretion. This certainly is so in the case of ordinary secretory cells (mucous, hepatic, etc.); and the hypertrophy experimentally produced when one of bilateral or portions of single internal secretory organs are removed practically proves our contention. That hypertrophy (? hyperplasia) of the ovaries can occur has been demonstrated in animals by Bond³ and others, who have found compensatory hypertrophy in the remaining ovary after removal of the other organ.

Occasionally unmarried women in the upper classes, between thirty and forty years of age, seek advice for menorrhagia. The ovaries of these patients are often large and tender, but free from disease. It seems likely that the unsatisfied physiological requirements of these women, whose sexual and maternal instincts are active, may in some cases lead to hyperplasia with excess of ovarian secretion (hyperoöphorism). This condition causes excessive menstruation with a large calcium excretion, and this, as is well known, may produce nervous phenomena. Parturition and lactation would have enabled such a patient to have adjusted her metabolism in a normal manner. This question is a difficult one, and it has not attracted the attention it deserves.

IV. *Displacements of the Genital Organs, and Venous Engorgement*.—Ovarian prolapse may sometimes be associated with menorrhagia; if so, it is probable that there is some irritation and engorgement of the ovary which leads to excessive secretion.

Uncomplicated downward and backward displacements of the uterus, when acquired, may give rise to menorrhagia, but this is not invariable. With puerperal retroflexion the heavy fundus falls back and overlies the ovarian veins, tending to obstruct the flow of blood within them. In time this causes oedema of the endo-

¹ W. Blair Bell, *Principles of Gynaecology*, 1910, p. 199.

² B. Whitehouse, Hunterian Lecture, *Lancet*, 1914, vol. i. p. 951.

³ C. J. Bond, *Brit. Med. Journ.*, 1906, vol. ii. p. 121.

metrium, which is usually associated with excessive menstruation. So, too, downward displacements interfere with the return of blood through the veins and may lead to menorrhagia, but not nearly so frequently as in the case of puerperal retroflexions. Epimenorrhoea is often seen with puerperal retroversion and retroflexion, but not with prolapse.

We may here mention that constipation, by producing a varicocele in the pampiniform plexus on the left side, sometimes gives rise to menorrhagia. It is probable, however, that this is not the only cause in many cases of excessive menstruation which are attributed to constipation.

V. Traumata.—Uterine bleeding from injury, except when caused during parturition, is rare. Stem pessaries are no longer used for prolapse, and rarely in this country for dysmenorrhoea. These intra-uterine instruments may give rise to menorrhagia and, if ulceration be produced, to metrostaxis. With procidentia, traumatic ulcers are often found on the projecting cervix or vaginal walls, and these may bleed. Although such bleeding cannot come into the category of functional disturbances, it may be said that there is a greater tendency for ulcers to bleed at the menstrual than at other times.

Obviously the cure of bleeding from the uterus due to local lesions depends on the treatment of the primary condition ; but we have not discussed the management of these lesions, for this will be found fully specified in other parts of this work—wherever the diseases to which we have alluded are described.

Epochal Menorrhagia, Metrostaxis and Epimenorrhoea

Epochal menorrhagia, metrostaxis and epimenorrhoea are uterine haemorrhages which occur at puberty and at the menopause. Although much that has already been written might be held to cover what we have now to discuss, it is advisable to consider epochal haemorrhages together since they are supposed by many to form clinical entities. We do so the more readily in order to demonstrate conspicuously that even though they are looked upon as clinical entities they really are not always, strictly speaking, scientific entities, any more than are haemorrhages during the reproductive period of life. It is, therefore, only by a proper appreciation of the causal factors in any particular case that we can direct the treatment to a successful issue.

Menorrhagia and Epimenorrhoea of Puberty.—It is often extremely difficult, as already indicated, to separate menorrhagia and epimenorrhoea. They may, and frequently do, coexist ; that is to say, menstruation may not only be too profuse and protracted, but may recur too frequently.

At puberty menorrhagia, when it occurs, nearly always coincides with the onset of menstruation, and there is usually nothing in the history of the girl to account for the disturbance. It is seen in the children of the rich and poor alike. The haemorrhage may be almost continuous, or menstruation may be very protracted, with only a few days' interval before it recommences. The patients are often reduced to an extreme condition of anaemia and prostration, and a few have actually died.

The etiology, as already indicated, is not always the same. The causes are either general or local, but by far the larger number of cases result from general or constitutional conditions. It is, however, always advisable to make a rectal examination under an anaesthetic before attempting treatment.

A. *General Causes*.—Not infrequently there is thyroid enlargement. This is often seen at puberty without any untoward symptoms, but when there is menorrhagia we may presume that the gland is too active. In most of these cases we have found a deficiency of lime salts in the blood and an excessive excretion in the urine. Such cases are best treated with calcium lactate and infundibulin; and if they be very obstinate a few short exposures of the thyroid to the X-rays sometimes prove beneficial. We have already discussed the meaning of thyroid enlargement at this time of life (see p. 303).

But there are other cases in which there is a normal excretion of calcium salts in the urine and no deficiency of them in the blood, nor is the thyroid enlarged. In these circumstances treatment is more difficult. In some the administration of horse serum is effective, probably indicating that there is some coagulative constituent deficient in the blood; in others serum appears to produce no certain effect. In the latter class of case the patient is generally flabby and debilitated, so, although she has plenty of calcium in her blood, the involuntary muscular system shows considerable loss of tone. There is, also, often a deficient nitrogen excretion in the urine. Such patients should be treated with massage, Swedish exercises, serum, a free nitrogenous diet and infundibular extract.

Where the cause is constitutional it is most important that the child be not converted into a chronic valetudinarian. We were recently consulted in the case of a girl, fourteen years of age, who had been kept in bed for two years, until she had become a spoiled, contented invalid. The parents, who would neither follow advice nor allow proper investigations to be made, were largely to blame for her condition. It is useless to undertake the treatment of these cases unless a free hand be given. Exercise, whenever possible, and fresh air are always essential. It is most important, too, that the child's mind should not be centred on her genital functions. Further, it is always advisable in cases in which the menorrhagia has been of long duration

to curette the endometrium, which is frequently oedematous owing to the continued menorrhagia, before commencing medicinal treatment, otherwise the abnormal condition of this structure prevents or delays recovery; but this surgical intervention must be considered only as accessory treatment.

B. Local Causes.—These often originate from general conditions: the uterus may be bulky owing to the flaccid condition of the muscle wall, in common with a similar state in the other involuntary muscles of the body. Or the ovaries may be large and produce an excessive secretion—sometimes owing to derangements in other endocrine organs, as, for instance, when there is insufficiency of the thyroid with menorrhagia due to this cause.

In spite of the rarity of local disease in these circumstances care is needed, otherwise gross lesions, such as ovarian cysts or solid tumours, may be overlooked.

Menopausal Menorrhagia, Epimenorrhoea and Metrostaxis.—Menopausal disorders of menstruation and metrostaxis are due to general and local causes. The latter are of great importance, owing to the danger of malignant diseases of the uterus being the source of the haemorrhage, for it is at or shortly before this period of life that cancer of the cervix most often develops.

A. General Causes.—Apart from the general causes of menorrhagia already mentioned, which although they may give rise to irregularities at the menopause need not be considered again here, there are certain causal factors which are more or less peculiar to this time of life. We have already seen that menstruation may be too profuse, following longer or shorter intervals than are normal to the particular patient, or there may be metrostaxis.

With the cessation of the ovarian function, to which the menopause is for the most part due, the thyroid and, less noticeably, other organs of internal secretion have their functions deranged, as we have described elsewhere.¹ In consequence of these disturbances epimenorrhoea, with or without menorrhagia, from temporary hyperthyroidism may be seen. The excessive thyroid activity is manifested, also, by the irritability of the patient both mentally and physically. There may be hysterical phenomena and muscular tremors, which even affect the speech.

These menstrual and general disturbances are usually controlled by rest and a quiet life. Calcium lactate alone or in conjunction with infundibulin may be prescribed with confidence when active treatment is deemed necessary.

Irregular haemorrhages, however, that is to say metrostaxis and too profuse menstruation at irregular periods, are often caused by unequal ovarian activity.

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47; Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. pp. 809, 937; *The Sex Complex*, 1916.

In other words, the secretion poured into the blood must reach a certain amount before menstruation is precipitated—for the moment leaving out of consideration other biochemical interactions and stimuli; but, with atrophic changes occurring in the ovaries, the secretion necessary to start menstruation is not produced in sufficient quantities to cause *regular* menstruation, although enough may be produced to bring about this phenomenon occasionally. When menstruation is precipitated in these circumstances, partly owing to the fact that the thyroid may also be active, and partly because the accumulation of ovarian secretion necessary to produce menstruation from the uterus, which is becoming fibrotic, is in excess of that required normally, the haemorrhage is apt to be profuse and protracted.

In most cases no treatment is necessary, beyond keeping the patient in bed during the continuance of the bleeding. The intervals tend to become longer, and menstruation less profuse.

B. Local Causes.—Pathological lesions, such as adenomatous polypi, fibromyomata and malignant diseases of the uterus, may cause metrostaxis and menorrhagia at the menopause, as at an earlier period of life; and they must be carefully distinguished from what we may call the more specific menopausal lesions, for they demand early operation. Unfortunately, malignant disease is occasionally overlooked with disastrous consequences.

The specific menopausal lesions in the uterus are dependent on the fibrosis which occurs both in the uterine muscle and the walls of contained vessels, and in the endometrium. We separate the two because the cause of the haemorrhage produced differs in the two situations.

(a) *Fibrosis of the Muscular Coats of the Uterus and Vessels.*—Owing to the fibrous tissue present contraction of the remaining uterine muscle is inefficient, and may fail properly to close the vessels. Also, the fibrotic changes in the muscular coats of the vessels themselves prevent diminution in their calibre being effected by contraction of the uterine muscle. It will be obvious how menorrhagia may occur in these circumstances, just as with the condition known as ‘fibrosis uteri.’ Direct treatment in this class of case is difficult. Fortunately expectant treatment is usually sufficient and the menopause gradually asserts itself before the patient suffers at all seriously from the losses of blood. Rest in bed during menstruation is advisable.

(b) *Fibrosis in the Endometrium*, as we first pointed out some years ago,¹ is responsible for a very curious condition which is apparently not uncommon.

The blood extravasated during menstruation is not all able to escape through the dense fibrotic endometrium, consequently small collections of blood of different

¹ W. Blair Bell, *Principles of Gynaecology*, 1910, p. 212.

ages may be found scattered throughout (Fig. 157). As a rule the whole endometrium is not involved, but it may be. This condition somewhat resembles that which has been described¹ as 'haemorrhagic endometritis,' in which, owing to the fibrosis of the endometrium following infection, menstrual blood cannot readily escape.

The effect is the same as that produced by a growth or foreign body in the uterus.

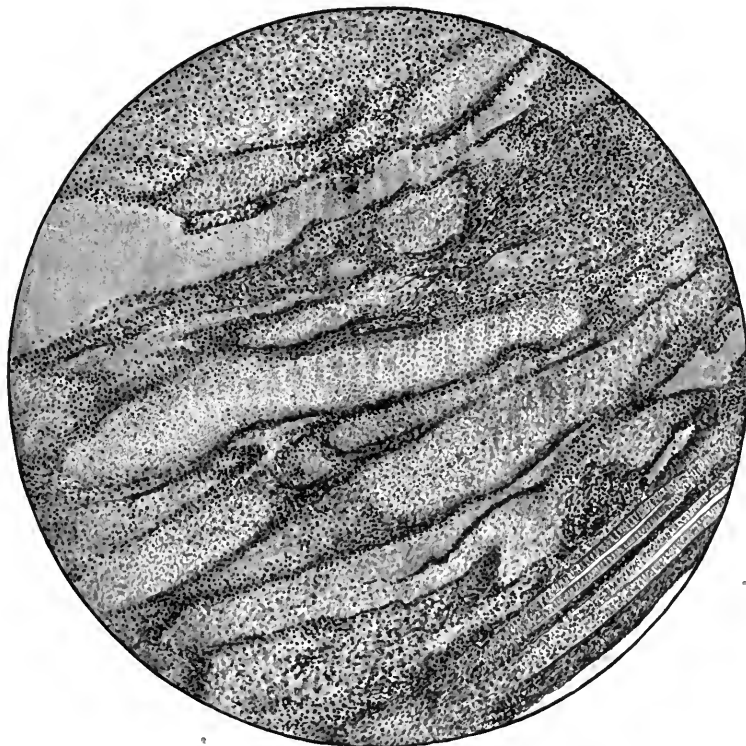


FIG. 157.—Section of endometrium from a case of menopausal menorrhagia and metrostaxis, showing collections of blood of different ages in the stroma. ($\times 60$.)

which leads to menorrhagia or metrostaxis. The treatment is simple and effective: curettement removes all the affected endometrium, and the menopause usually follows on normal lines. So impressed have we been with the frequency of this condition and the simplicity of the cure, that, failing to find any other definite lesion, we would advise curettement in all serious cases of menopausal menorrhagia, epimenorrhoea and metrostaxis.

¹ C. C. Norris, *Amer. Journ. Obstet.*, 1909, vol. lix, p. 399.

Dysmenorrhoea

Painful menstruation is a common disorder in women, but is primary, that is commences at puberty, comparatively rarely.¹

When investigating a case of dysmenorrhoea we are usually told by the patient that for several or many years menstruation was painless, but that when she was between twenty and thirty years of age dysmenorrhoea commenced. These facts are well known, and the recent statistics obtained by Catherine Chisholm² from students and teachers in schools bear them out. So long ago as 1878 Mary P. Jacobi,³ in the final paragraph of her essay concerning rest during menstruation, made the following statement: "It remains true, however, that in our existing social conditions 46 per cent of women suffer more or less at menstruation, and for a large number of these when engaged in industrial pursuits or others, under the command of an employer, humanity dictates that rest from work during the period of pain be afforded whenever practicable." If this were true thirty-seven years ago, it is probable that the percentage of women who suffer with dysmenorrhoea is far greater at the present time.

In our discussion of the subject we shall endeavour to indicate, on the one hand, those causes which produce dysmenorrhoea from puberty onwards, and, on the other, those which give rise to dysmenorrhoea at a later date. In this way it would be possible to describe dysmenorrhoea as *primary* or *secondary*; but, important though this distinction is, for practical purposes and in order to avoid repetition we prefer to consider the subject here from a wider standpoint.

We shall, therefore, consider painful menstruation with regard to the causal factors: whether they be anatomical or physiological derangements, or whether they be gross pathological lesions unassociated with the morphology or physiology of the genital organs. In doing this we shall describe as far as possible the actual pathological condition; and we shall, therefore, discard such terms as 'congestive' or 'spasmodic' dysmenorrhoea. Indeed, what we may call true dysmenorrhoeas are nearly all due to uterine colic, whereas congestion produces a totally different type of pain. Moreover, whether the pain be premenstrual, menstrual or post-menstrual in time depends largely on the cause.

Dysmenorrhoea due to Structural Anomalies.—This form of dysmenorrhoea is primary, and exists, therefore, from the onset of menstruation. The irregularities

¹ Catherine Chisholm, *Journ. Obstet. and Gyn. British Empire*, 1913, vol. xxiii. pp. 288, 389; Marie Tobler, *Monatsschr. f. Geb. u. Gyn.*, 1907, vol. xxvi. p. 801.

² Catherine Chisholm, *loc. cit.*

³ Mary P. Jacobi, *The Question of Rest for Women during Menstruation*, 1878, p. 232.

in structure are developmental, occurring either in foetal life or between birth and puberty. The pain is due to uterine colic, and occurs only during the menstrual flow.

The abnormalities which may be found are: (1) Under-developed uterus of normal shape; (2) under-developed uterus with acute flexion; (3) fully-developed uterus with acute flexion; (4) gross malformations of the uterus.

I. *Under-developed Uterus of normal shape*.—Sometimes there is no dysmenorrhoea with this type of anatomical irregularity, but merely scanty menstruation. In many cases, however, not only is the menstruation scanty but the pain caused by uterine colic is severe, and is present only during the period of flow from the uterus. The pain is probably caused in two ways: first, by the irregular contractions of the uterus whose musculature is badly developed and largely replaced by fibrous tissue; and second, because, owing to the density and fibrosis of the endometrium which is usually found in these uteri, the discharge has some difficulty in breaking through, and may thus give rise to increased and painful contractions in the surrounding muscle wall.

Treatment is often unsatisfactory, dilatation and curettement giving but temporary, if any relief. As a rule, patients with badly developed uteri are sterile. If, however, they do become pregnant, as sometimes happens, they may be cured thereby of their menstrual disabilities.

In these cases we must endeavour to improve the development of the uterus. If the patient be over the age of about twenty years it will probably be impossible to obtain any satisfactory result in this respect; but if the patient be under this age there is a possibility that with suitable treatment some improvement may be accomplished. Efforts should be made to discover whether there be insufficiency of the thyroid or pituitary secretions: the metabolism must be investigated especially in regard to carbohydrate tolerance, and sometimes a skiagram of the sella turcica may be useful, to show whether the pituitary is at fault (see Fig. 144, p. 296). Should insufficiency be discovered in any endocrine organ the treatment consists in augmentation by means of the prepared animal extract. According to our experience the best results are to be expected when there is insufficiency of the thyroid; and, even if the patient be too old to allow of further development of the uterus, relief from pain is often obtained by the administration of the thyroid extract. When organo-therapy is undertaken the treatment must be carried on for years if there be any sign of improvement. Whether inactivity of the ovaries may sometimes be the primary causal factor in these cases is not known. It appears to us, however, that when the ovaries remain under-developed after the normal period of puberty the fault rarely lies primarily

in these organs themselves, especially when they are normal in position, but rather in some of the other organs of internal secretion upon which the development of the genitalia so largely depends. Consequently ovarian extract alone is likely to be of little value, even supposing an ideal preparation were obtainable, whereas ovarian extract in combination with other extracts is often useful.

The general health and hygiene of the patient must also be carefully attended to.

Hard muscular exercise and mental stress must be avoided. A fresh-air life and free protein diet should be recommended: the former for its general invigorating effect, and the latter for stimulating the thyroid, since the work of Chalmers Watson¹ leads us to believe that thyroid activity varies with the food, and that a protein diet stimulates the thyroid, at any rate for a time. Whether this be the true explanation or not, these patients do better with plenty of nitrogenous food.

II. *Under-developed Uteri with acute Flexions (Cochleate Uteri).*—All that has been said already in regard to scanty menstruation and dysmenorrhoea connected with a normally shaped and under-developed uterus

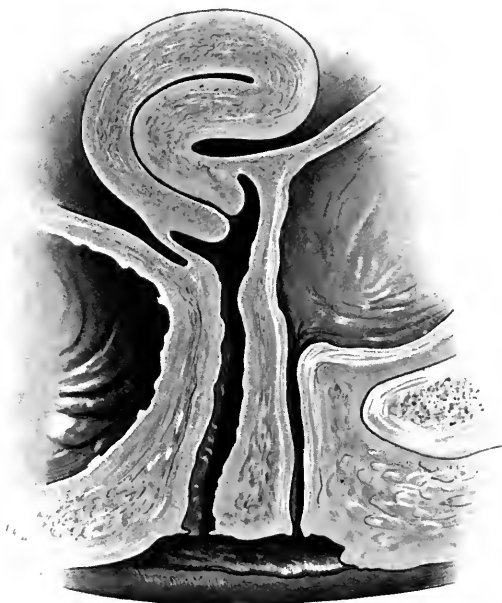


FIG. 158.—Acute anteversion with under-development of the uterus. (Cochleate uterus.)

applies to under-developed uteri with acute flexions; but the menstrual pain in the case of the latter is usually much more severe. Indeed, it is probable that there is no more severe form of dysmenorrhoea, if we except some cases due to exfoliation of the endometrium (*q.v.*).

The peculiar severity of the pain is undoubtedly caused by the kink in the uterus (Fig. 158). This kink probably does not cause obstruction to the flow, at any rate to the extent formerly believed. The pain is essentially of a colicky type, and in all probability is due, as we have elsewhere stated, to the blocking of waves of contraction—already painful owing to the bad development and fibrosis of the general musculature of the uterus—at the site of the kink (Fig. 159), where at the

¹ Chalmers Watson, *Journ. Physiol.*, 1904, vol. xxxi. (*Proc. Physiol. Soc.* p. v); *Arch. Röntgen Ray*, 1904-5, vol. ix, p. 259.

PLATE VII
Vol. I

Section of anterior wall, at the site of the kink, of an under-developed cochleate uterus, stained by Van Gieson's method, showing the large amount of fibrous tissue in the muscle wall and endometrium, and, also, the irregular disposition of the muscle fibres and fibrous tissues at this angle of flexion. Inset is a section of normal uterine muscle and endometrium, stained by the same method, for comparison.

× 40

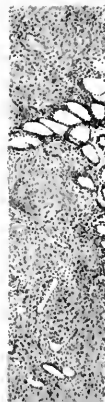
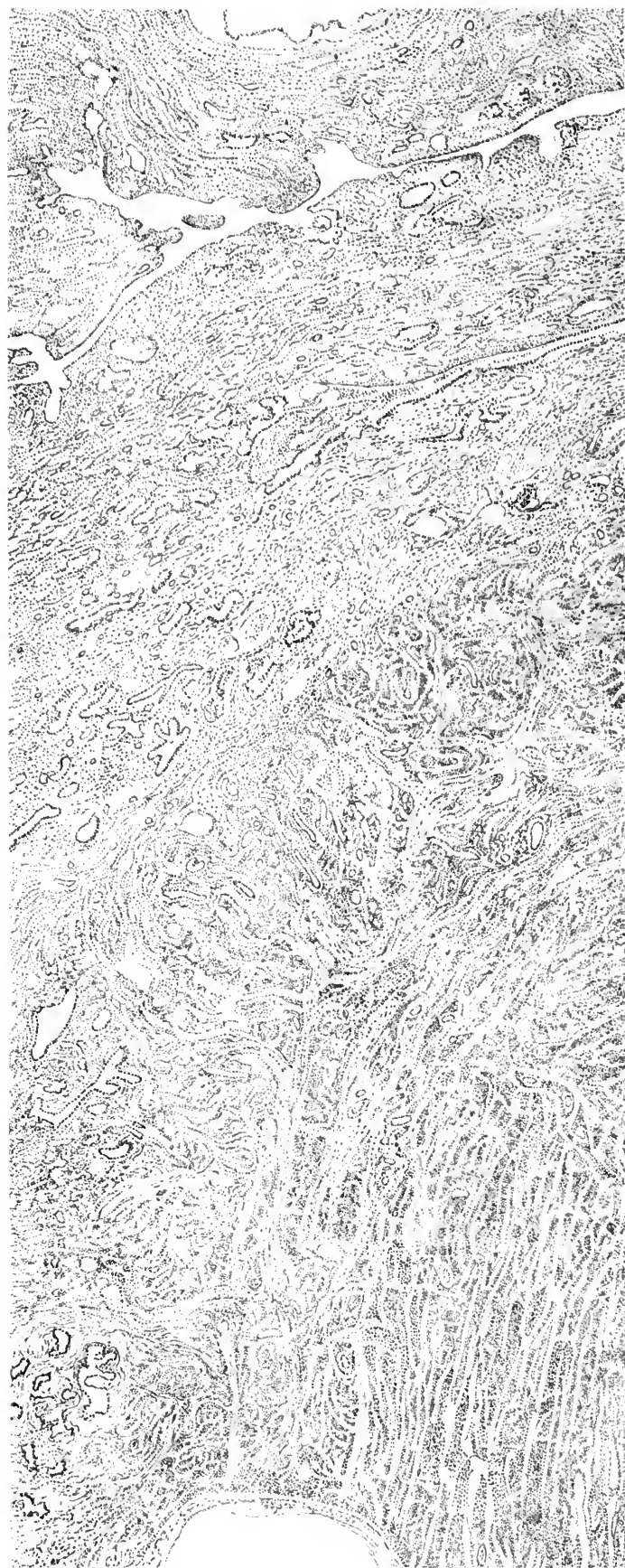


PLATE VIII
Vol. I

Section of posterior wall, at the site of the kink, of an under - developed cochleate uterus, stained by Van Gieson's method showing the more regular arrangement of the muscle fibres and fibrous tissues as compared with that seen in the section from the anterior wall. It will be noticed that the endometrium in this and Plate VII is partly duplicated, in order to make each complete.

× 40



point of flexion the muscle tissue is found to be most interlaced with bundles of fibrous tissue¹ (Plate VII.). The wall of the uterus opposite to the direction of flexion is made up of muscle fibres and fibrous tissue more regularly disposed (Plate VIII.). The flexion is most commonly anterior. Acute developmental retroflexion is an extremely rare condition.

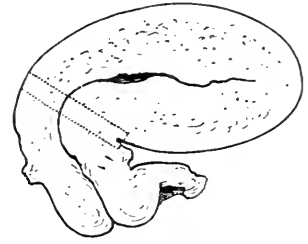


FIG. 159.—Outline drawing of under-developed coeleate uterus. Sections from the anterior and posterior walls at the site of the 'kink,' as shown within the dotted lines, are illustrated in Plates VII. and VIII. ($\times \frac{1}{2}$)

The general treatment of these cases is based on the principles already discussed in connexion with under-development of the normally shaped organ. The further development of the uterus must be carefully fostered if the patient be not too old. Local treatment, also, is always advisable in these cases, for, as is not the case with the normally shaped under-developed uterus, considerable relief from dysmenorrhoea can be obtained by operative procedures when there is an acute flexion. The majority of gynaecologists employ dilatation of the cervix with or without curettement. Dilatation of the cervix gives temporary relief in many cases by straightening the uterine canal and stretching the internal os which, as already mentioned, is surrounded by an imperfectly developed musculature; but, as a rule, the result is only temporary. Curettement also, by removing the dense endometrium, opens up the way for the formation of a fresh and more normal lining membrane.

Splitting the vaginal cervix has also been practised, but the results are not good: there is no permanent improvement in the dysmenorrhoea, so far as we have been able to learn from patients on whom this operation has been performed.

In consequence of the doubtful or temporary benefit of the ordinary procedures we have been led to practise an operation of anterior or posterior hysterotomy, according to the direction of the flexion, which we will proceed to describe, for it has usually given extremely good results in our hands so far as the acute menstrual pain has been concerned; indeed, some of our patients who previously suffered intensely have never had the slightest dysmenorrhoea subsequently to operation.

Anterior Hysterotomy (author's procedure).—This is performed when there is acute ante flexion. The patient is prepared for operation in the ordinary way, and when fully anaesthetized is placed in the lithotomy position. The vulva and vagina are then sterilized with tincture of iodine. A short curved retractor held by an assistant is used to draw back the perineum and expose the cervix, the sides of which are seized with volsella and drawn downwards and backwards as far as possible.

¹ W. Blair Bell, *Principles of Gynaecology*, 1910, p. 204.

The cervix is now dilated in the ordinary way to a moderate degree with Hegar's metal dilators, and the uterus curetted.

The patient is, of course, often a virgin and always nulliparous, so the chief difficulties are experienced in drawing down the cervix and properly exposing the anterior fornix for the subsequent steps in the operation: usually it is necessary

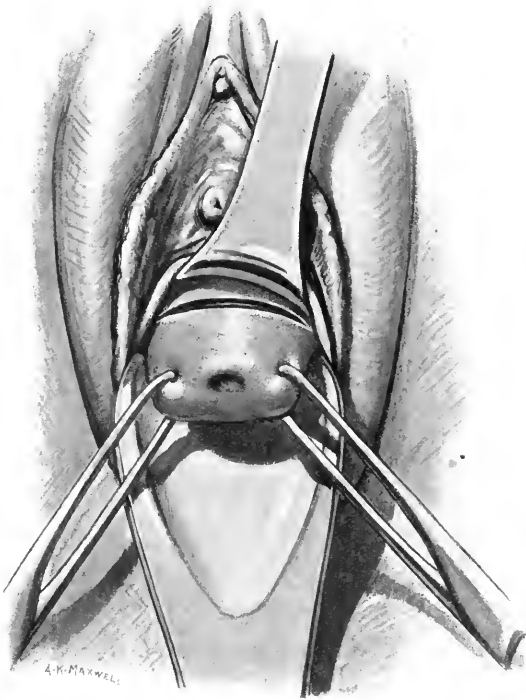


FIG. 160.—Anterior hysterotomy for acute ante-flexion with dysmenorrhoea (author's procedure), showing the division of the vaginal mucosa in front of the cervix.

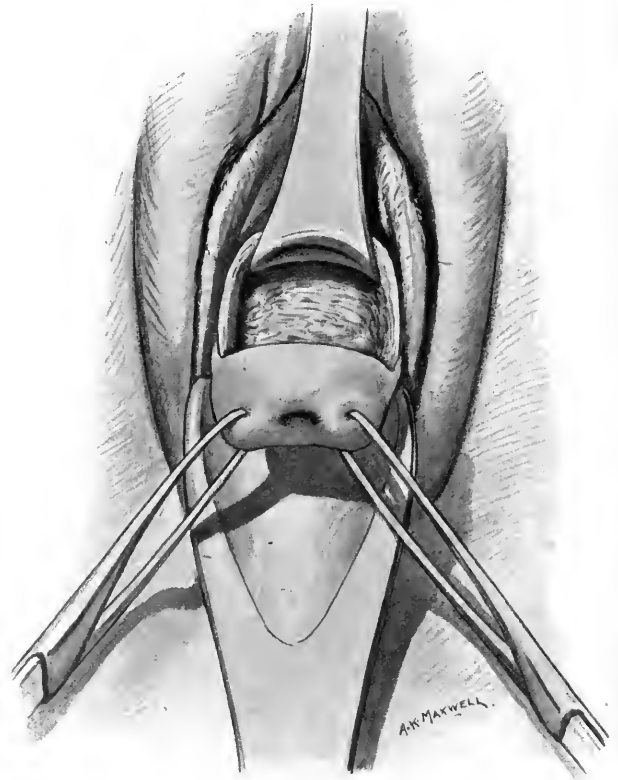


FIG. 161.—Anterior hysterotomy (author's procedure), showing the access obtained to the supravaginal cervix after the bladder has been pushed up beyond the internal os uteri.

to expose this region by the insertion of a short narrow retractor. A transverse incision an inch in length, slightly above the junction of the vaginal mucosa with the cervix in front, is now made with a knife (Fig. 160). This incision is deepened until the cervix is reached. The bladder is next pushed up as far as possible: the distance is decided by the exposure of the level of the internal os uteri which can be felt as a distinct ridge beneath the finger-tip. A narrow retractor is now inserted into the opening thus made to keep the bladder out of the way (Fig. 161). The anterior

wall of the cervix is then divided throughout its whole extent, including that part surrounding the internal os which is laid open. This division of the cervix may be carried out with scissors, one blade of which has been passed along the dilated canal, or a dilator may be reinserted and the whole length of the cervix cut through with a

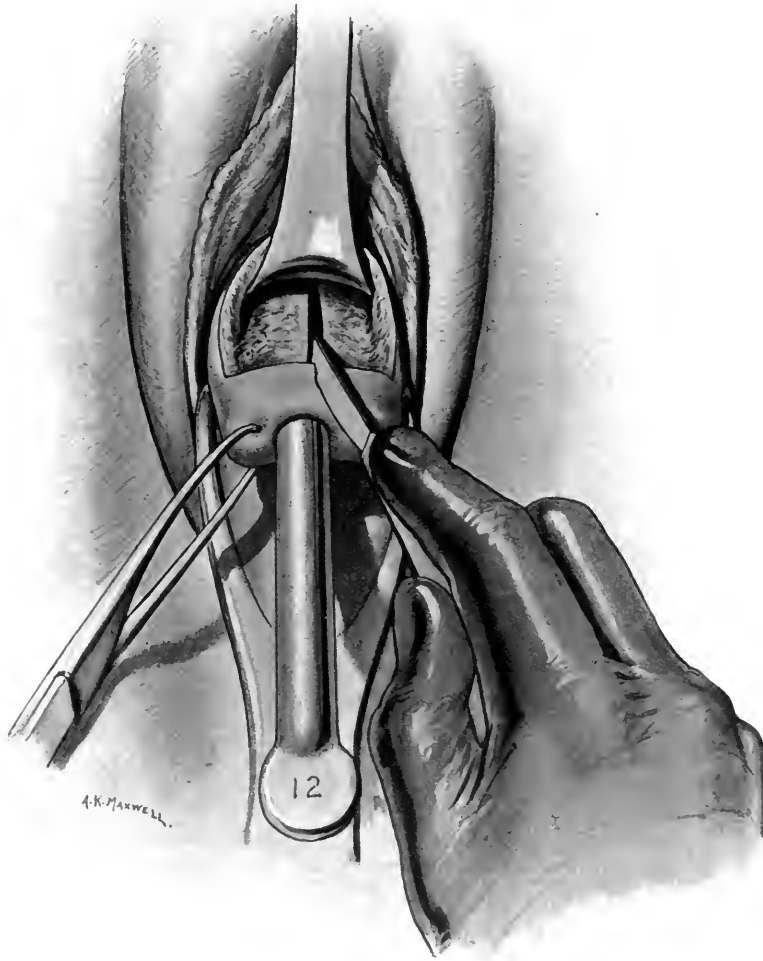


FIG. 162.—Anterior hysterotomy (author's procedure), showing central division of the cervix.

knife from without inwards (Fig. 162). The dilator is now moved about so that the operator may be quite certain that the cervix around the internal os has been completely divided. Next, the supravaginal cervix is brought together *superficially* with a continuous suture, or a few interrupted sutures, of fine chromic catgut (Fig. 163); and, finally, the vaginal wall is sutured in position with ordinary catgut. At

the close of the operation, and subsequently, nothing abnormal is seen except the division of the anterior wall of the vaginal cervix which is not sutured (Fig. 164).

The patient is kept in bed for a week and douched occasionally with tincture of iodine in water (5ij to Oj) to remove any blood-clots from the vagina.

Posterior hysterotomy is practised when there is acute retroflexion. This

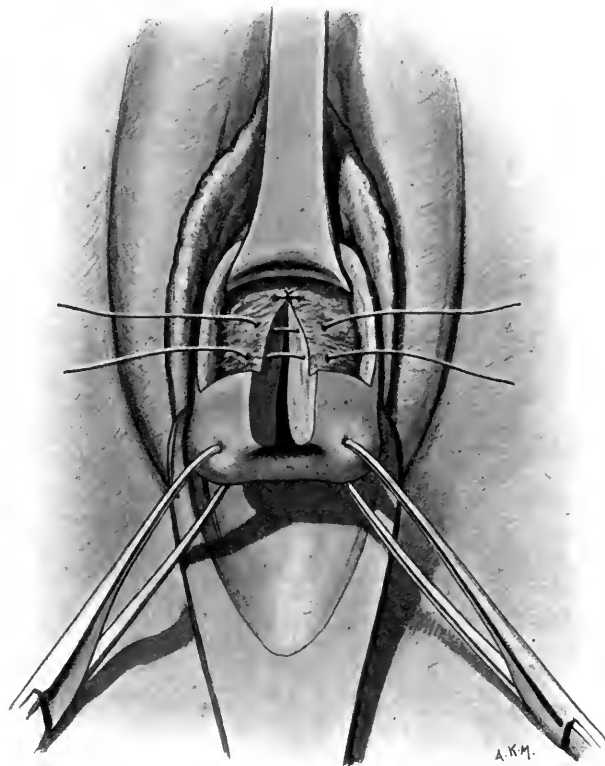


FIG. 163.—Anterior hysterotomy (author's procedure), showing the superficial sutures placed in the supravaginal cervix.

operation is the same as anterior hysterotomy except that the transverse incision is made in the posterior fornix, the peritoneum of the pouch of Douglas pushed up instead of the bladder and the cervix divided behind instead of in front. The operation is then completed in the manner already described.

III. *Fully-developed Uteri with acute Flexions*.—When the body of the uterus is fully developed dysmenorrhoea from flexions is usually not so severe as that occurring in under-developed organs. The pain is due to uterine colic, and is either primary or secondary. Antelexion is far commoner than retroflexion as a developmental

error. These conditions must be distinguished, the former from the normal ante-flexion and version, and the latter from simple retroversion which is usually symptomless.

When the uterus is not cochleate in shape, it is usually sufficient to dilate the

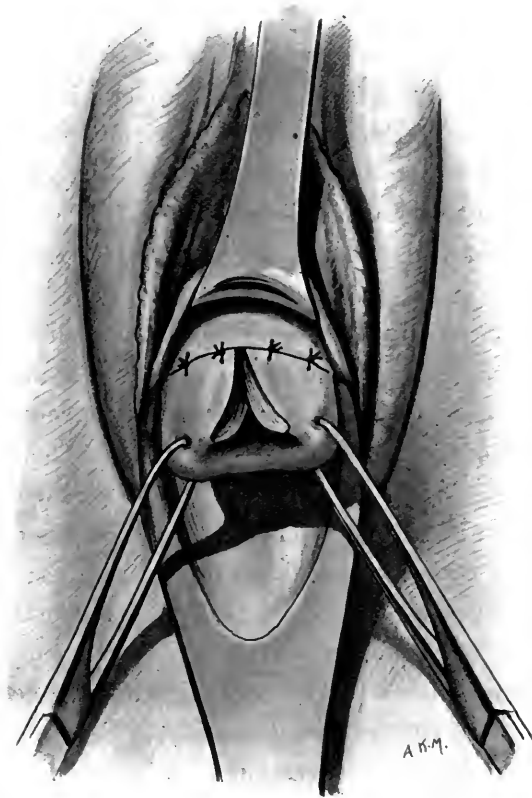


FIG. 164.—Anterior hysterotomy (author's procedure), showing the operation completed by the replacement of the vaginal mucosa.

cervical canal to a moderate extent. It is, however, possible that the symptoms will return after a few months' relief. If so, the case must be considered with regard to the further treatment. Marriage frequently brings relief to those patients, and pregnancy always. So, as they are not usually sterile, it is worth while to temporize, and especially to dilate the cervix just before marriage, if this be contemplated. When there is retroflexion repeated abortion may occur, and for this further operative procedures may become necessary; here, however, we are only concerned with dysmenorrhoea.

Occasionally, when the patient is over twenty-five years of age, is earning

her livelihood and is unlikely to marry, we have performed hysterotomy, as already described, with a good result. This operation, however, should usually be reserved for the under-developed uterus which is unlikely to become pregnant. We know of no case in which conception has occurred after we have performed this operation, but it is possible that in such circumstances the complete division of the cervix might lead to trouble.

For dysmenorrhoea due to the structural anomalies just described some American surgeons have strongly advocated the use of hollow metal intra-uterine stem pessaries. Carstens,¹ Dickinson² and Watkins³ make somewhat extravagant claims regarding the uses and advantages of these instruments, which have not found much favour in this country owing to the obvious disadvantages and dangers they possess, and the natural feeling against such prolonged treatment when simple operations usually give equally satisfactory or better results.

IV. *Gross Malformations of the Uterus*.—When the malformation in the Müllerian tract is very marked there may of course be complete amenorrhoea; but when menstruation takes place it is often associated with dysmenorrhoea. The treatment is surgical, and the procedure to be adopted depends on the character of the lesion.

(a) *Bicornute Uteri*.—When the uterus is irregularly bicornute the incompletely developed horn may give rise to dysmenorrhoea in the same way as the normally shaped under-developed uterus, which has already been described. Cases in which there is dysmenorrhoea owing to the retention of menstrual fluid in a badly developed uterine horn with stenosed outlet, while menstruation takes place painlessly from the other horn with a patent cervical canal, are occasionally seen.

In these circumstances the treatment consists in the removal, if possible, of the horn which is badly developed, while the other which is functioning normally is spared, for not infrequently conception and parturition occur. Occasionally it is impossible to remove one horn without the other.

(b) *Conical Cervix with pin-hole Os*.—Dysmenorrhoea is not a constant phenomenon with this malformation; sometimes the patient seeks advice because of menstrual pain, but quite as frequently on account of sterility. It appears, therefore, that the dysmenorrhoea is not wholly dependent on the conical cervix and small external os uteri. Probably the pain when present arises from a combination of circumstances which react on one another. Thus, we may find that the body of the uterus is also badly developed, and is, in fact, the cause of the dysmenorrhoea. Again, in those

¹ J. H. Carstens, *Amer. Journ. Obstet.*, 1913, vol. xlviii. p. 720.

² R. L. Dickinson and W. S. Smith, *Amer. Journ. Obstet.*, 1913, vol. lxviii. p. 686.

³ T. J. Watkins, *Surg. Gyn. and Obstet.*, 1913, vol. xvii. p. 461.

cases in which there is exfoliation of endometrium or clotting of blood in the uterine cavity there will be greater pain during the passage through the narrowed cervical canal than through the normal cervix. It appears probable, too, that a badly developed cervix with a pin-hole os would not soften and dilate during menstruation in the way a normal cervix does. This might involve the internal os, and prevent the usual menstrual relaxation in this situation. It will be obvious, from the foregoing remarks, that the dysmenorrhoea is often primary, and sometimes secondary.

Treatment consists in dilating the cervix or performing a plastic operation to prevent recurrence of the condition. The plastic operations will be discussed under 'Sterility,' for which condition they are most frequently performed (see p. 404).

Dysmenorrhoea due to Physiological Anomalies.—Under this heading we shall describe those types of dysmenorrhoea which are due to some disturbance of the normal physiological processes. The only definitely recognizable anomalies are intra-uterine clotting of the menstrual blood and excessive exfoliation of the endometrium. We shall deal later with excessive follicular haemorrhage, which can hardly be said to give rise to dysmenorrhoea although the pain may be intense.

Dysmenorrhoea due to physiological irregularities rarely occurs at puberty, contrasting, therefore, with the primary forms of dysmenorrhoea due to anatomical anomalies which we have already discussed. The pain is always menstrual in time, and is due to uterine colic. A special feature of these forms of dysmenorrhoea is that they may be inconstant; that is to say, the patient may have severe pain at one period and none at the next.

I. Intra-uterine Clotting of Menstrual Blood.—We have shown elsewhere,¹ that normally the menstrual blood does not clot owing to the destruction or abstraction of the formed fibrin ferment or its precursors by the vital processes of the endometrium; and it follows, therefore, that pathological clotting of the menstrual discharge is due to the presence of fibrin ferment.

On the other hand Whitehouse,² who confirmed our finding in regard to the absence of fibrin ferment in menstrual discharge, believes that normally the blood clots in the uterus, but that a proteolytic ferment (thrombolysin), formed by the glands in the body of the uterus, dissolves the clots in the vagina. It seems, at first sight, extremely unlikely that clotting could occur at all in the presence of a ferment which is capable of resolving a formed clot; but, until we are able to submit further

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1911, vol. iv. p. 234; *Journ. Obstet. and Gyn. British Empire*, 1912, vol. xxi. p. 209; *Journ. Path. and Bacteriol.*, Cambridge, 1914, vol. xviii. p. 461.

² B. Whitehouse. Hunterian Lecture, *Lancet*, 1914, vol. i. p. 877.

experimental evidence on this point, we prefer to leave open the question of the cause of the destruction or abstraction of the fibrin ferment. We believe that in those cases in which there is clotting, either the endometrium is not normal or the flow is so profuse that the fibrin ferment or its precursors escape unaltered in the blood which is poured out.

It is difficult exactly to define all the cases in which we may expect to find coagulation. With such a gross lesion as a submucous fibromyoma clotting always occurs ; but the pain at the menstrual period in this case is due rather to the growth



FIG. 165.—Section of laminated clot *in situ* within the uterine cavity, from a patient who suffered with severe dysmenorrhoea. ($\times 60$.)

(From section kindly lent by W. E. Fothergill.)

than to the blood-clots. When, however, we examine a large number of cases we find that in similar conditions, such as prolapsus uteri, puerperal retroflexion and 'fibrosis uteri,' there may be clotting of the menstrual blood or there may not be ; and, again, we find that clotting sometimes occurs when the uterus appears to be normal.¹ It is, therefore, always important in obtaining the history in cases of dysmenorrhoea to find out if clots are passed, and, if necessary, to examine the menstrual discharge for fibrin ferment. Naturally there will be no dysmenorrhoea

¹ W. Blair Bell, *Journ. Path. and Bacteriol.*, Cambridge, 1914, vol. xviii. p. 461.

from this cause unless the clots are *formed in the uterus*; and this, in our opinion, is comparatively unusual even in those cases in which clots are found in the vagina. Whitehouse, however, believes that clots are formed normally in the uterus.¹

When there is menstrual pain it is caused by the expulsion of the coagulated blood through the cervix. The clot is sometimes retained in the uterus for many hours (Fig. 165), and, when expelled, is found to be modelled to the shape of the uterine cavity, forming a blood cast of it (Fig. 166). The casts vary in density according to the length of time they have been retained. Sections (Figs. 165, 167) usually show nothing but fibrin, blood corpuscles and leucocytes, although occasionally a small fragment of endometrium may be found embedded in the blood.



FIG. 166.—Blood-casts expelled from the uterus during menstruation. (Photograph.) ($\times \frac{1}{4}$.)

We have already seen that the formation of the blood-clot is dependent on the abnormal presence of fibrin ferment. As a rule, however, in these circumstances the blood is expelled into the vagina before coagulation occurs, and consequently the patient does not suffer with dysmenorrhoea. But when the tone of the uterine muscle is deficient—and this may be recognized clinically by the flabbiness and softness of the organ—the cavity may become slightly distended with blood which clots *in situ*. Usually, moreover, in these cases the onset of the flow is rapid and the bleeding profuse.

Treatment is directed, on the one hand, to checking the rate of the menstrual flow; for, as already pointed out, if the menstrual blood escape rapidly there may

¹ B. Whitehouse, Hunterian Lecture, *Lancet*, 1914, vol. i. p. 877.

be no time or opportunity for the endometrium to deal with the fibrin ferment, consequently the blood clots after it has escaped into the uterine cavity. And, on the other hand, the want of tone in the musculature must be overcome in order that the blood may be expelled into the vagina before it has had time to coagulate.

It so happens that if we improve the tone of the muscular walls of the uterus we also check the rate of menstrual flow at the same time; for, as we have already seen, menorrhagia may be caused by loss of tone in the uterine walls.

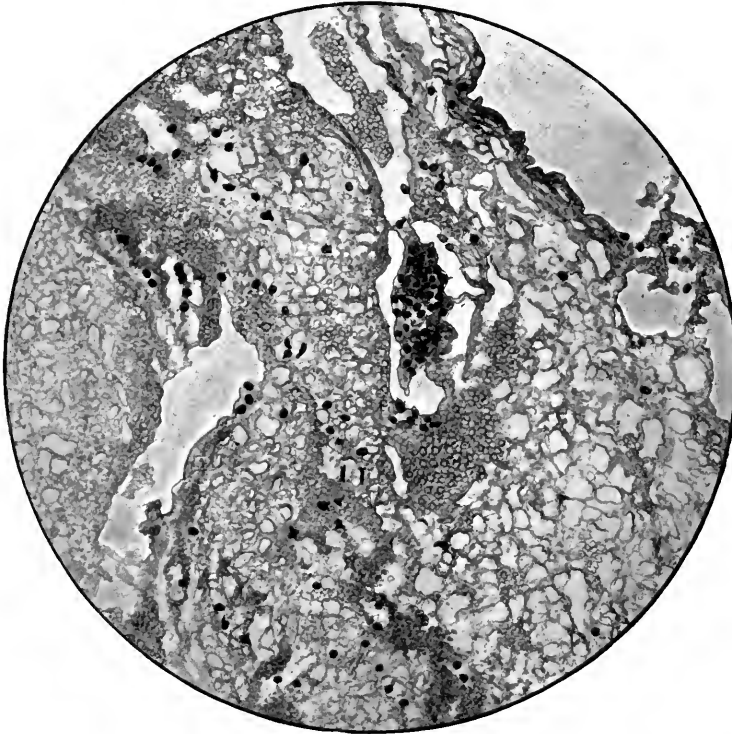


FIG. 167.—Section of menstrual blood-clot, showing fibrin, red-blood corpuscles, and leucocytes. ($\times 250$.)

Any drug which causes uterine contraction will accomplish what is required. We ourselves prefer to use calcium lactate in large doses (gr. xxx in water every night for one week, and then every other night) in the milder cases, since the calcium salts in the blood are largely responsible for the tone of involuntary muscle. If, however, menorrhagia be severe it is advisable to prescribe infundibulin also. This is best given hypodermically in doses of 0.5 c.c. of a 20 per cent solution; but it may be administered orally in tablet form, the dose being gr. ii. twice a day.

If the formation of blood-casts in the uterus and their expulsion be the only

cause of the dysmenorrhoea in any given case, the prognosis is very good; indeed, it is one of the most satisfactory of all forms of dysmenorrhoea to treat.

II. *Exfoliation of the Endometrium*.—Investigations have shown¹ that normally there is a considerable variation in the extent of denudation of the endometrium during menstruation in different individuals. In some hardly more than small pieces of surface epithelium here and there are disturbed; in others most of the superficial layer is cast off in fragments. When the pieces detached are small no pain is caused during their expulsion. It is only under special circumstances, to be discussed directly, that exfoliation of the endometrium gives rise to dysmenorrhoea. This type of menstrual pain has been known as 'membranous dysmenorrhoea.'

We have lately investigated a number of these cases from both clinical and pathological points of view,² and have arrived at the following conclusions: The exfoliation may be superficial or deep—that is to say, either only a superficial layer of the endometrium is stripped off, in which case a *thin menstrual cast* of the uterus is expelled, or the exfoliation is deeper giving rise to a



FIG. 168.—Thin endometrial casts exfoliated during menstruation. (Photograph.) ($\times \frac{1}{2}$.)

thick menstrual cast. These casts are rarely perfect. The classical description of a membranous bag, with three apertures representing the os internum and the orifices of the tubes, is misleading, for, although such specimens may occasionally be seen, they are very rare. Usually the cast is in two halves or in smaller pieces. In general appearance they vary considerably: the thin cast is semi-transparent and resembles tissue paper (Fig. 168), whereas the thick casts cannot be distinguished macroscopically from the decidual casts of early abortions (Fig. 169, a, b).

Occasionally there is passed what is known as a 'solid cast' (Fig. 169, c): this consists of rolled-up membranes and coagulated blood welded into a solid mass.

¹ W. Blair Bell, J. Bamforth and E. E. Glynn (about to be published); Hitschmann and Adler, *Monatsschr. f. Geb. u. Gyn.*, 1908, vol. xxvii. p. 1; R. Schröder, *Archiv f. Gyn.*, 1912, vol. xeviii. p. 81.

² W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1912, vol. v. p. 153; *Surg. Gyn. and Obstet.*, 1913, vol. xvi. p. 651.

In section they are seen to have the same histological characteristics as the thick and thin casts.



FIG. 169.—*a, b*, Thick endometrial casts, exfoliated during menstruation; *c*, 'solid' cast of rolled-up endometrium, exfoliated during menstruation and mixed with blood. (Photograph.) ($\times \frac{1}{4}$.)

It is somewhat difficult to observe properly in many specimens the histological structure, because they often become disintegrated while lying in the uterus or vagina before they are obtained for fixation. If, however, good specimens be secured the same picture is always seen: a marked menstrual decidua-like reaction in the stroma-cells, which may be

separated (Fig. 170) or packed tightly together (Fig. 171). The surface epithelium

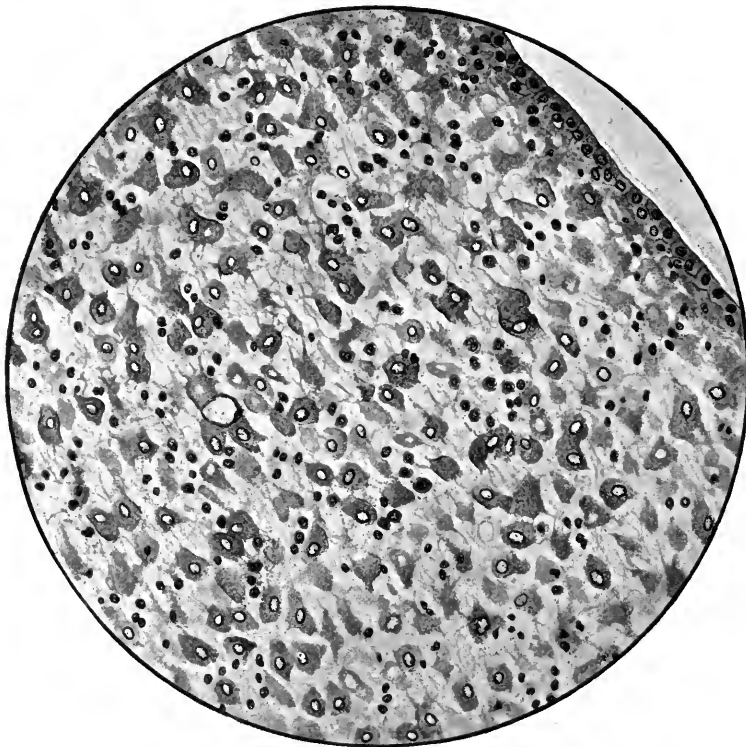


FIG. 170.—Section of thick endometrial cast, showing the flattened surface-epithelium and decidua-like reaction in the superficial stroma-cells. ($\times 250$.)

is, of course, intact, and is much flattened (Fig. 170). There is usually a considerable effusion of serum and blood corpuscles in the stroma, which in places separates

the cells and gives rise to a 'ground glass' appearance in the portions affected. The glands show short columnar epithelium with clear nuclei, and there is no secretion to be seen within the lumina (Fig. 172). These macroscopical and microscopical appearances of menstrual casts lead to a discussion of their etiology and the clinical symptoms associated with them.

In days gone by it was almost universally held that these casts were the result of conception; that they were in fact nothing more or less than decidual abortions.¹

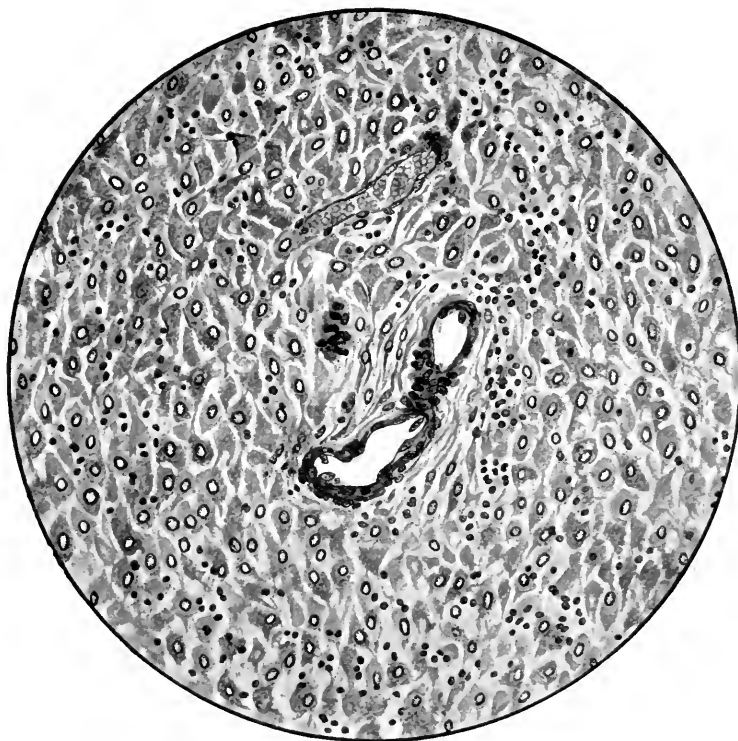


FIG. 171.—Section of thick endometrial cast, showing decidua-like reaction in the stroma-cells around deeply placed vessels. ($\times 250$.)

This view in regard to the thick casts appears to be held by some to this day. The macroscopical appearance and the presence of decidua-like cells are brought forward as evidence of their connexion with conception. Further, it has been argued that if the patient be separated from her husband she will cease to pass these membranes.²

With regard to these contentions, our investigations led us to the following conclusions. In the first place we do not think it possible to distinguish *macroscopically* a thick cast from a decidual abortion. Each consists of altered endo-

¹ R. Cory and others, *Trans. Obstet. Soc.*, 1878, vol. xx. p. 113 *et seq.*; J. Matthews Duncan, *Sterility in Woman*, 1884, p. 6; Hausman, *Berl. Beitr. z. Geb. u. Gyn.*, 1872, Bd. i. s. 155.

² R. Cory and others, *loc. cit.*; discussion following paper, *Roy. Soc. Med.*, 1912, vol. v. p. 153.

metrium which has been forcibly detached, and each is smooth on the free surface and ragged on the surface separated from the uterine wall. Microscopically, however, it is quite a simple matter for any one accustomed to examining these specimens to distinguish between the two. In the menstrual membrane the cells are less well preserved, and they are, even when well fixed, smaller than those in the product of conception; they are, also, more irregular in shape, especially near the surface,



FIG. 172.—Section of thick endometrial cast, showing ground-glass appearance of stroma due to blood corpuscles and serum. ($\times 250$.)

and usually are more widely separated in the menstrual cast (Fig. 170), features due, probably, to degenerative changes.

With regard to the third point mentioned, no one of experience should uphold for a moment the contention that the history of these cases shows that they are products of conception. Among many others we investigated the histories of two sisters, one married to a doctor and the other unmarried. Both passed thick casts. We were assured by the medical man who was the husband of one of them that, in the case of his wife, sexual intercourse had been temporarily abandoned on more than one occasion in order to test whether the membranes were decidual abortions

or not. It was found that the casts were passed as frequently in the absence of the possibility of conception.

Again, similarly conclusive proof of a different character was obtained in the case of the patient who passed the cast shown in Fig. 169, *a* and *b*. This patient, who was married but childless, was operated on by us for double salpingitis—probably of tuberculous origin—and both tubes were removed. Subsequently she commenced to pass menstrual casts of which seven different specimens were examined at different times. A few years later, while she was still passing casts, we performed an operation for the removal of a cyst of the left ovary of the size of a coco-nut. No trace of any orifice could be found in the fundus of the uterus, which was quite smooth except for a small omental adhesion at the spot where the right tube had been removed. It was obvious impregnation could not have occurred.

On the other hand, in another case in which *thin* casts, shown in Fig. 168, were passed, the patient only expelled membranes when having intercourse with her husband. She had been twice married, and commenced to pass the membranes during her second marriage, but not at all regularly. The explanation of this and many similar cases which have been recorded is, probably, that sexual intercourse produces a greater menstrual decidua-like reaction in the stroma, just as it may increase the menstrual discharge; and it is, we believe, on this decidua-like reaction that the exfoliation depends.

Several observers, and we ourselves,¹ have found that normally both the superficial and deep layers of stroma-cells of the endometrium may swell and become decidua-like in the premenstrual period (Figs. 173, 174). This apparently does not occur to the same extent in every individual. It is interesting, too, that in the majority of cases this reaction, when it is found in the deeper parts of the endometrium, occurs in patches, especially around the vessels (Fig. 174). Usually the blood can find its way to the surface, but when the decidua-like reaction is particularly well marked and universal it forms a barrier to the passage of sanguineous effusion through the endometrium into the uterine cavity; consequently the endometrium becomes stripped off by the accumulation of blood behind the plane where the stroma-cells have become most densely packed together, and is shed into the cavity of the uterus. It is worthy of note that in many of these cases there is menorrhagia which further assists the denudation just described. The chief symptom, when there are any, is dysmenorrhoea, sometimes of a very severe type. But it may be said at once that in our opinion, which is contrary to that usually expressed, dysmenorrhoea due to

¹ W. Blair Bell, J. Bamforth and E. E. Glynn (about to be published); Hitschmann and Adler, *Monatsschr. f. Geb. u. Gyn.*, 1908, vol. xxvii. p. 1; R. Schröder, *Archiv f. Gyn.*, 1912, vol. xcvi. p. 81.

exfoliation of the endometrium and expulsion of the membrane is not nearly so common as exfoliation without pain.

It appears that the thin membranes usually escape without becoming rolled up, and therefore painlessly. Even the thick casts may in the same way, but less frequently, be passed almost without pain. If, however, the cast be retained in the uterus for any length of time it becomes rolled up, mixed with blood and stuck



FIG. 173.—Section of the normal premenstrual endometrium, showing decidual-like reaction in the stroma-cells near the surface. ($\times 250$.)

together in a rounded mass forming the 'solid cast' (Fig. 169, c), the passage of which naturally gives rise to very severe dysmenorrhoea.

Many women suffering with this condition are sterile, but cases are on record in which the passage of casts only commenced after the birth of children.¹ On the other hand, excessive menstrual exfoliation has been cured after the patient has borne children.

Treatment has proved very unsatisfactory. Some cases have been cured by curettement, but this fortunate result is undoubtedly rare, and at the present time there is no treatment which is in the least specific.

¹ S. J. Aarons, *Brit. Gyn. Journ.*, 1907, vol. xxii, pt. lxxxix, p. 3.

If there be severe menorrhagia, calcium lactate, in the doses previously mentioned, should be given; for when the menorrhagia is checked there is less tendency to exfoliation of the endometrium. In addition the muscle tone is improved, and in consequence immediate and painless expulsion of the membrane may be brought about. There is a still further advantage in large doses of this salt, for a decrease is produced in the power of the cells of the body to imbibe fluid from the serum with

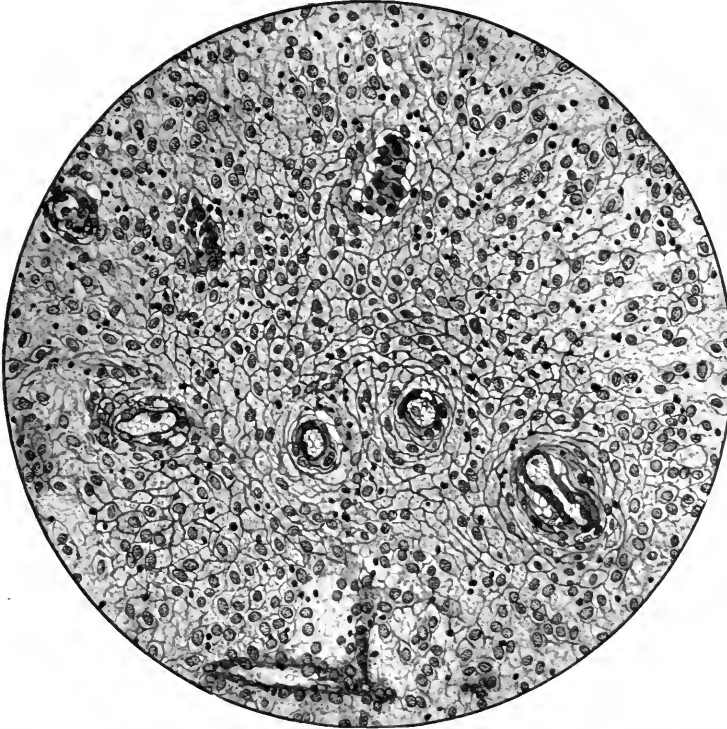


FIG. 174.—Section of the normal premenstrual endometrium, showing decidua-like reaction in the stroma-cells around the deeply placed blood-vessels. ($\times 250$.)

which they are bathed when it is rich in calcium salts; ¹ the decidua-like reaction in the endometrium may, therefore, be lessened or prevented. Thyroid extract may also be given in some cases with very good results. It is prescribed with a view of bringing on the period a day or two earlier, before the decidua-like reaction in the endometrium has had time to become well developed. This extract may be combined with the calcium lactate. Various other remedies have been recommended, but the very multiplicity of methods of treatment indicates the uselessness of most of them, and we make no claim to specificity for the treatment recommended above, but it is at least based on scientific grounds, and it is often surprisingly effective.

¹ W. Blair Bell, Discussion on Calcium Therapy, Brit. Med. Assoc., *Brit. Med. Journ.*, 1912, vol. ii. p. 698.

Before closing this discussion of uterine casts we must allude to two other forms of casts, apart from blood-clots and exfoliated endometria, which have been said to occur. It is most important that the question of menstrual casts should be thoroughly cleared up, for the teaching on the subject is now very vague. We may say at once we are convinced that no other *menstrual* casts than those already described ever occur.

'*Fibrinous casts*' have been described,¹ in which small fragments of endometrium may be found. Further it has been stated that these are the commonest form of menstrual cast giving rise to dysmenorrhoea;² and this has been generally taught. We ourselves have not met with a single specimen of a true fibrinous cast, and we are more than sceptical as to their separate existence. It appears to us certain that they have been mistaken for old blood-clots, possibly with shreds of endometrium enclosed. One of the writers quoted above now agrees with this opinion.³ A true fibrinous cast could only be formed as the result of a membrane-forming infection of the endometrium, which surely would not occur as a cyclical process. It is interesting to observe how much confusion can arise as the result of imperfect or erroneous pathological observations. '*Mucous casts*' are also said to occur.⁴ We have never met with one; and with regular menstruation fail to understand how such a cast would be formed in the body of the uterus. Further, it is obvious that it would be necessary for the mucus to become inspissated before it could form a cast.

III. *Painful Ovulation*.—Ovulation does not necessarily occur in association with menstruation; but when it does it may give rise to pain. This is usually the result of some infective lesion enclosing the ovary in adhesions. Sometimes, however, painful ovulation occurs in apparently normal ovaries. We say "apparently normal" for, although normal to the naked eye, they may on microscopical examination show a dense stroma and thickened tunica albuginea; yet we must remember that these changes are normal late in the reproductive period of life, and do not then give rise to pain. It is possible, of course, that towards the menopause ovulation does not occur very often; and this may be why pain is not complained of. This fibrotic condition of the ovaries early in life may be due to mumps or acute fevers in childhood. We have, however, very little real evidence concerning dysmenorrhoea due to painful ovulation in non-adherent ovaries. As a rule, the patients are of the neuropathic type.

¹ F. H. Champneys, *Lancet*, 1890, vol. ii. p. 1313; W. E. Fothergill, *Trans. North Eng. Gyn. Soc.*, 1902, p. 7.

² W. E. Fothergill, *loc. cit.*

³ W. E. Fothergill, private communication.

⁴ F. H. Champneys, *loc. cit.*

There is no doubt, also, that the hæmorrhage from a Graafian follicle may itself cause peritoneal pain. We believe that this is due to the action of fibrin ferment on the peritoneum, for in one case in which we performed abdominal section during menstruation we found several ounces of blood in the pelvis. There had been no pain, and the blood was free from fibrin ferment. In this case it was doubtful whence the blood had come, for there was no recently ruptured follicle. Russell Andrews,¹ also, has reported two cases of retained menses with free fluid blood in the peritoneal cavity which caused neither pain nor adhesions. Other operators quoted by Andrews have had similar experiences.

It is almost certain, as we have observed during operations, that normally no blood escapes from the follicle into the peritoneal cavity, for the ovum is probably swept out in the first gush of liquor folliculi when the follicle ruptures, and the effused blood clots *in situ*.

Dysmenorrhœa due to acquired Pathological Lesions.—Under this heading we shall mention very briefly the chief pathological lesions, the result of acquired conditions, which are responsible for dysmenorrhœa. We shall not discuss the treatment of them, for that is dealt with in the sections devoted to the study of the diseases in question.

A. Constitutional Diseases.—Many diseases of the general system may give rise to dysmenorrhœa, although usually the *modus operandi* is extremely indefinite. In the first place we have to bear in mind that women vary greatly in their sensibility to pain, so when we consider the nervous system in relation to dysmenorrhœa we are confronted with the difficulty of estimating the mental factor which is often largely responsible for the severity or otherwise of the suffering. This, of course, applies to all forms of pain; no less to the conditions giving rise to dysmenorrhœa, already discussed, than to those more directly associated with the state of the sensorium. But when the pain is due to some definite cause, and is therefore real—if we may so use the term—it is merely part of the duty of the surgeon to recognize the fact that what is bearable pain to one woman is unbearable to another.

I. Disorders of the Nervous System.—Hysteria frequently and neurasthenia sometimes appear to bring in their wake dysmenorrhœa, whose severity it is difficult to gauge. We have no right to deny that these patients suffer with the pain of which they complain, simply because the genital organs appear to be healthy. Those same intoxications which are probably responsible for the general disturbance of the nervous system may give rise to painful and irregular contractions of the involuntary muscles.

¹ Russell Andrews, *Journ. Obstet. and Gyn. British Empire*, 1911, vol. xix. p. 521.

This is well recognized in connexion with the intestines; and we can readily believe that during menstruation the uterine contractions, which are normally regular and painless, may in the individual who suffers with 'functional' disorders of the nervous system become irregular and painful; also, that the pelvic congestion sometimes associated with the onset of menstruation, but normally escaping notice, gives rise to feelings of intense weight and aching in the supersensitive woman.

II. General Toxaemias.—Apart from those toxaemias which cause the nervous disturbances just mentioned, about which we know so little, there are other well-known intoxications which may lead to local changes in the genital organs and thus occasionally give rise to dysmenorrhoea. Rheumatism,¹ syphilis² and auto-intoxication from the colon³ have all received attention.

Rheumatism appears to produce neuralgic conditions in the genital organs which may be accentuated, or brought into consciousness at the menstrual periods. It is probable that the so-called 'chill,' which by so many patients is given as the causal factor in the history of the onset of their pain, is due to reduction in the individual resistance to rheumatic and other toxaemias.

Intestinal intoxications are said to give rise to sclerosis of the ovary with cyst formation; and syphilis is now believed to produce 'fibrosis uteri,' which is sometimes responsible for menstrual pain. It is possible, too, although we are unaware of any recorded case, that lead poisoning might produce uterine colic, just as it does intestinal colic.

We know definitely very little concerning the general infections of acute fevers such as scarlet fever or typhoid, but it is likely that they, too, are capable of producing changes in the musculature of the uterus. Mumps occasionally gives rise to what is known as metastatic oöphoritis, which may cause intense dysmenorrhoea until the condition has subsided; in some cases fibrosis of the ovaries ensues, as already stated.

B. Local Lesions in the Pelvis.—Dysmenorrhoea is very commonly an accompaniment of gross lesions of the genitalia (infections, displacements, new growths and traumata), or of the neighbouring structures in the pelvis.

I. Infections.—These may be acquired, firstly by infection *per vaginam*, as in the case of puerperal, operative or venereal infections; secondly, by infection from the bowel—primarily in appendicitis and sigmoiditis, or secondarily when ovarian cysts and other growths become adherent to bowel; and thirdly, by blood infections of the genitalia, such as may occur in tuberculous disease.

¹ J. Halliday Croom, *System of Gynaecology*, edited by Allbutt, Playfair and Eden, 1906, p. 82.

² B. Whitehouse, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1914, vol. vii. p. 123.

³ Arbuthnot Lane, *Proc. Roy. Soc. Med., Supplement*, 1913, vol. v. No. 5, p. 49.

Now, infections may involve the ovaries and tubes alone, or the uterus, ovaries and tubes. The dysmenorrhoea which results from these lesions is premenstrual in time, and sometimes, when the uterus is involved, menstrual as well. It represents what used to be called 'congestive dysmenorrhoea,' and is of an aching, and in bad cases of a tearing character. The pain is caused in different ways according to the situation of the lesion. If from ovarian lesions, the pain may be produced by the inability of the Graafian follicles, into which haemorrhage has occurred, to rupture and discharge their contents, owing to the adhesions in which the ovary is buried; consequently blood-cysts form. These cysts on section are found to be lined with lutein cells. Sometimes the pain associated with blood-cysts is so acute that the patient becomes collapsed, and in these circumstances she has been operated on under the impression that she was suffering from an ectopic gestation, or appendicitis with pelvic effusion. Often, however, these corpora lutea blood-cysts are not formed; for the Graafian follicles ripen and then degenerate without the escape of blood into them. Under these conditions the follicles become cystic, and the dysmenorrhoea produced is of a stretching or tearing character when the blood supply is increased during menstruation.

The Fallopian tubes may also be involved by infections, and be bound down with adhesions which give rise to a sense of weight and stretching at the menstrual periods.

When the wall of the uterus is infected it may become fibrotic; and, as a result, pain is caused not only by local congestion, but also by the irregular contractions of the uterine musculature, which occur during the flow.

II. *Acquired Displacements.*—The only displacements which are of importance in regard to dysmenorrhoea are retroflexion and prolapse.

Retroflexion may be associated with salpingitis or with uterine tumours, in which circumstances the menstrual pain is not directly due to the position of the uterus. But when the retroflexion is of puerperal origin or the result of a strain, the subsequent dysmenorrhoea, if there be any, is directly due to the position of the fundus uteri. The puerperal uterus is subinvolved and heavy, and the fundus, by overlying the ovarian veins, causes 'back pressure,' in consequence of which the endometrium becomes oedematous. As we have already mentioned, clots may form in the uterus so displaced and give rise to dysmenorrhoea on their expulsion. But the pain primarily associated with the condition is due to congestion, which becomes accentuated at the menstrual period by the obstruction of the venous circulation. It is, therefore, premenstrual in time. When the uterus is dislocated backwards by strain, as may occur in girls while playing hockey or lifting heavy weights, the utero-sacral ligaments may encircle the fundus. This gives rise to premenstrual

congestive pain, and also to menstrual colic. Unless the fundus be situated in the pouch of Douglas dysmenorrhoea is seldom produced.

If there be dysmenorrhoea from prolapsus uteri, which is very rarely the case, the pain is also due to the congestion which may be produced in the displaced organ. Indeed, puerperal retroflexion is usually the first stage in most cases of prolapse.

III. *New Growths*.—If growths of the ovaries and tubes produce dysmenorrhoea, they do so by becoming fixed to surrounding structures and interfering with the circulation of the parts, or forcing the uterus out of position.

Malignant growths of the uterus do not often cause pain during menstruation. Uterine fibromyomata, however, play a considerable part in the production of menstrual pain; they frequently, but not always, give rise to uterine colic. This result is brought about in two ways: first, if the fibromyoma be completely intramural it interferes with the normal waves of contraction and gives rise to irregularity; and second, if the growth be polypoid within the cavity of the uterus the contractions which occur during menstruation are increased by the foreign body which they attempt to expel. Dysmenorrhoea due to this last cause is often of a very severe character.

IV. *Traumata*.—Injury is a rare causal factor in the production of dysmenorrhoea. The ordinary lacerations of the cervix due to parturition probably decrease the liability to menstrual pain. But when the body of the uterus has been subjected to mutilations, such as the incision of Caesarean section or the enucleation of fibromyomata, scars may be produced which cause considerable menstrual colic. As a rule the muscular wall of the uterus, owing to its vascularity, heals well without the intervention of much fibrous tissue, but this does not always happen, especially in women over forty years of age, in whom considerable cicatrization may occur.

V. *Constipation*.—Apart from general toxæmic effects which may be produced by constipation, there is a very important and common local effect: obstruction of the left ovarian vein. This venous obstruction may in turn lead to varicosity of the pampiniform plexus and congestion of the ovary. With this condition the patient usually suffers with a dull, heavy, aching premenstrual pain of a character similar to that produced by displacements.

General Considerations in connexion with Dysmenorrhoea.—In the foregoing pages we have dealt with dysmenorrhoea on a pathological basis. In this way only can a complete survey of this common disorder of menstruation be discussed scientifically and clearly in a limited space without repetition. We have endeavoured to show that the cause bears a definite relationship to the pain, and that the latter can only effectually be dealt with by an appreciation of the former.

We have avoided all mention of palliative treatment so far as the pain itself is concerned. All pains can be relieved if we care to adopt extreme measures in the matter of drugs. The belief that analgesics form the basis of treatment directed towards the relief of dysmenorrhoea has kept back the proper study of the causal factors which should be treated rather than the pain itself. Of course, there are circumstances in the life of certain patients which may render any radical treatment inadvisable, and then we may turn to analgesic drugs. So, too, with so-called hysterical and rheumatic dysmenorrhoeas, or that following a chill, we must temporize with drugs while the essential cause is being treated. The drugs which should be used are the coal-tar derivatives, such as phenazone. Acetyl-salicylic acid, also, has in our hands given most satisfactory results. Hot non-alcoholic drinks and hip baths may be employed with immediate benefit, and some patients find sufficient relief from a hot-water bottle applied to the abdomen. Under no circumstances should gin or other alcoholic drinks, which certainly give relief, be prescribed; nor should opium or morphia ever be given, lest a habit be established.

Unfortunately in the past there have been operators unscientific and reckless enough to perform double oöphorectomy for dysmenorrhoea, sometimes with disastrous mental results. We know of one young lady who has spent her life in an asylum since this operation was performed for the relief of menstrual pain. Such a procedure can, therefore, never be justifiable. It would be quite a different thing to remove a malformed or under-developed uterus in which there is little or no probability of conception taking place, without interfering with the ovaries; but as we have already indicated there are less drastic measures which are usually sufficient to give relief.

Other Disorders associated with the Menstrual Function

Intermenstrual Pain ('Mittelschmerz').—Regular intermenstrual pelvic pain dependent on cyclical changes in the genitalia is of very rare occurrence; although, from the amount of discussion to which it has given rise, one might infer that the condition was a common one.

Owing to the fact that it may recur regularly most clinicians hold that it must be due to ovulation.¹ But we must remember that ovulation itself is not a phenomenon which necessarily occurs each month, and, further, that we have no evidence to show that dehiscence of the follicle always takes place at the same time in the menstrual cycle. All operators must frequently have observed, on the one hand, the absence of any ripe or previously ruptured follicle during menstruation, and, on the

¹ J. Halliday Croom, *System of Gynaecology*, edited by Allbutt, Playfair and Eden, 1906, p. 104.

other, the presence of a ripe or recently ruptured follicle in no apparent relationship to the menstrual cycle. Lawson Tait¹ was one of the first to call attention to these points.

We know so little about the connexion of ovulation with menstruation in the human female that it is pure conjecture to ascribe intermenstrual pain to this process. At the same time it must be admitted this is the only theory which presents any semblance of likelihood. It may be argued, however, that if dehiscence were the cause of intermenstrual pain we should expect it to be a common disorder, whereas, as we have already stated, it is very rare. On the other hand, it may be contended that in those women who suffer with this complaint ovulation occurs at a regular and fixed time in the middle of the menstrual cycle, and that owing to the absence of pelvic congestion at this period dehiscence is slow and painful. And further, by way of analogy, it is possible that in some cases pain during menstruation is of ovarian origin when ovulation coincides with that function (see p. 368).

Addinsell² has reported several cases of regular intermenstrual pain which appeared to have been due to salpingitis. But in the discussion following the papers most of the speakers who described cases in their own experience were undecided as to their opinion of the cause and effect. The evidence, however, appears to point to the fact that lesions in the neighbourhood of the ovary may cause pain between the menstrual periods if ovulation regularly occurs at that time; consequently intermenstrual pain is probably not due to any one pathological entity, but the result of inflammatory diseases of the appendages, fibromyomata and other less well-defined lesions.

When there is gross pelvic disease, such as salpingitis, surgical treatment may lead to a satisfactory result; otherwise, unless we can discover the pathology of the condition, no satisfactory treatment is known to us, and we are obliged to fall back on palliative measures, such as the administration of analgesics.

Vicarious Menstruation.—A few years ago it was the fashion to ridicule the possibility of vicarious menstruation, although there can be little doubt that such a condition—first very definitely and scientifically described by Hippocrates³—is not at all uncommon. There are, we believe, two types, the *true* and *accessory*, both of which we have ourselves met with on several occasions.

I. *True vicarious menstruation* occurs when the patient bleeds from some mucous surface *instead of from the endometrium*, or in the absence of or with rudimentary

¹ Lawson Tait, *Med. Times*, London, 1884, vol. i. p. 619.

² A. W. Addinsell, *Trans. Obstet. Soc.*, 1898, vol. xl. p. 137; and 1899, vol. xli. p. 3.

³ Hippocrates, *Aphorisms*, translation by Francis Adams, *Sydenham Soc.*, 1849, vol. ii. p. 743, Nos. 32 and 33.

development of the uterus. In the first type of case the vicarious haemorrhage takes the place of menstruation or leads to its suppression; and in the second, which is very rare, the vicarious haemorrhage represents menstruation. Thus a tuberculous patient may have a severe haemoptysis, or a girl with gastric ulcer may have haematemesis just before a menstrual period—probably owing to metabolic disturbances associated with menstruation—with suppression of the menses, as Hippocrates¹ so shrewdly observed. On the other hand, in the absence of a uterus, or when there is a rudimentary organ with active ovaries, a girl may menstruate from one of the distant mucous surfaces each month—the commonest places being the nose, the stomach or the lower bowel—or even from the nipples. No treatment should be adopted in the absence or with maldevelopment of the genital passages, for the bleeding usually gives relief to headache and other molimina. When the haemorrhage occurs at the site of an organic lesion treatment is of course directed towards the primary disease.

II. *Accessory vicarious menstruation* implies that bleeding occurs from some distant site *as well as from the endometrium*.

The place from which the accessory bleeding occurs may be the site of a pathological lesion, such as tuberculous ulceration in the lung or ulceration of the gastric mucosa, or even a sinus or recent injury. On the other hand, bleeding may take place from a mucous surface which is apparently normal. Sometimes in these cases there is menorrhagia. We treated successfully with calcium lactate and normal horse serum a delicate girl of eighteen, who vomited large quantities of blood every month during menstruation, and at no other time.

Menstrual Mastidynia.—The fully developed breasts of the adult woman are very sensitive, and not infrequently become much more so during menstruation; indeed, women usually look upon some tenderness in the breasts during the catamenia as a normal phenomenon. Occasionally, however, women, especially nulliparae, suffer at these times with extreme tenderness, and sometimes with neuralgic pains; there may, also, be hyperaesthesia of the skin of the breasts. In a bad case the patient is quite unable to go about or do her work, the pressure of the clothing or the weight of the breasts causing intense pain.

The pathology of the condition is unknown, but we have observed that these patients frequently have a long menstrual cycle, that is to say over thirty days; and that the pain is most acute just before the commencement of menstruation.

Obviously, therefore, treatment lies in endeavouring to shorten the menstrual

¹ Hippocrates, *Aphorisms*, translation by Francis Adams, *Sydenham Soc.*, 1849, vol. ii. p. 743, Nos. 32 and 33.

interval, and this can usually be accomplished by the administration of thyroid extract. Three grains should be taken by the patient every night when she goes to bed, commencing on the twenty-first day since the beginning of the previous period. Some preparation of belladonna should also be prescribed, for it is not unlikely that secretion, or at least activity in and swelling of the glandular elements, occurs in the breasts and gives rise to the pain experienced. We have obtained very good results with these drugs given together.

Pregnancy may entirely cure the patient of mastidynia.

Excessive follicular Haemorrhage.—We have already seen that pain may be caused by bleeding from the Graafian follicle when dehiscence occurs. As a rule, the bleeding is negligible in quantity and does not escape into the peritoneal cavity; but in exceptional cases very severe haemorrhage may take place—so severe that a haematocele is formed, or, as occurred in one case with which we were acquainted and in which a post-mortem examination was made, death may rapidly supervene from loss of blood and shock. These cases may, therefore, resemble in the character and severity of their symptoms the termination of an ectopic pregnancy. No doubt if an examination were made fullness and tenderness in the posterior fornix could always be recognized.

It is possible that there is some pathological condition, general or local, of a chronic or temporary nature, which causes the excessive haemorrhage; and this, if discovered, must be treated on the lines already laid down.

Hystero-epilepsy.—This condition is a pathological entity and occurs only in association with the menstrual function. It must, however, be pointed out that practically all female epileptics suffer from more fits during menstruation than during the interval. Indeed, the fits during the menstrual week may greatly exceed in number those occurring during the other three weeks of the month.¹ As we shall show directly, this periodic increase in the frequency of true epileptic seizures is in all probability due to the same causes as those which lead to hystero-epilepsy.

This disorder is seen both in those who otherwise menstruate normally, and in those who cannot menstruate owing to the absence or malformation of the uterus, yet have active ovaries. Probably the worst cases are those in which there is no menstruation. In some the epileptic seizures occur with great regularity and severity, and, in consequence, the mind and health of the individual may be seriously impaired. When the attacks occur with menstruation they are as a rule of a minor character, and may resemble *petit mal*.

Some years ago we observed two of these cases carefully, and found that in the

¹ A. R. Litteljohn, *Lancet*, 1909, vol. i. p. 1382.

interval the patients had a low calcium index in the blood, and that the sudden further drop, which always occurs at the onset of menstruation, reduced the blood calcium index to such a low level (0.2 in one case) that epileptiform seizures resulted. We also found that these cases could be successfully treated by the administration of calcium salts.¹ Ringer,² many years previously, had proved that calcium salts reduce muscular excitability.

Since our work was published Voetglin and MacCallum³ have shown that the convulsive seizures following thyroid-parathyroidectomy can be controlled by the intravenous infusion of calcium salts. Litteljohn⁴ of the Hanwell Asylum, also, has found that the fits of true epileptics, which occur in female patients so much more frequently during menstruation, can be checked to an astonishing degree by the administration of calcium compounds. Since our original observations we have treated successfully with calcium salts many other cases.

When, however, there is no menstruation owing to the absence of the uterus, and the condition is precipitated solely by cyclical ovarian activity, probably the best treatment is to remove all but a small portion of one ovary. We have never ourselves seen or investigated such a case, but Lockyer⁵ successfully treated one patient, whose condition was serious, by the complete removal of both ovaries.

Menstrual Psychoses.⁶—Apart from the effects primary mental diseases may have on menstruation, which have already been mentioned, it is well recognized that various mental derangements may occur both as the result of disturbances of menstruation and in association with the otherwise apparently normal catamenia.

Before attempting to classify the various conditions met with, it is necessary to point out that both the manifestations and the prognosis are worse in an individual who has a neuropathic family history or individual tendency; indeed, it is generally difficult in these circumstances to say whether menstruation or some special disorder of this function is the cause of the condition, or has only precipitated the attack or aggravated the mental instability of the patient, in the same way as an attack of true epilepsy may be excited. Nevertheless, it appears probable that certain psychoses may be initiated as well as aggravated by menstruation or some disorder of this function.

In a consideration of the subject it is advisable, as indicated above, not to limit too closely our discussion to psychoses which occur only during menstruation (the

¹ W. Blair Bell, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1908, vol. i. p. 291.

² S. Ringer, *Journ. Physiol.*, 1884, vol. v. p. 247; and 1887, vol. viii. p. 20.

³ C. Voetglin and W. G. MacCallum, *Journ. Pharmacol. and Exper. Therap.*, 1911, vol. ii. p. 421.

⁴ A. R. Litteljohn, *Lancet*, 1909, vol. i. p. 1382.

⁵ C. Lockyer, *Trans. Obstet. Soc.*, London, 1906, vol. xlviii. p. 75.

⁶ See also *Psychoses of Puberty*, p. 298.

'psychosis menstrualis' of Krafft-Ebing), but also to include those which may be supposed to depend on a disturbance of the function, such as amenorrhoea. Many authors include in the term 'menstrual psychosis' the mental derangements seen at puberty and the menopause: such a classification is given by König.¹ But it appears simpler to discuss the epochal psychoses under the description of disorders of puberty and the menopause, and to confine the term 'menstrual psychosis' to mental disturbance dependent on the cyclical occurrence of menstruation or some anomaly of it. It is, nevertheless, obvious that some psychoses of puberty are exactly the same as those seen later in life, puberty having been merely the starting-point of the exciting cause—menstruation.

I. *Psychoses occurring during Menstruation.*—These are probably very common, and may, as pointed out by König,¹ occur regularly at each menstrual period or only occasionally. Further, the seriousness of the psychosis may vary from a very slight alteration in temperament to serious mental irresponsibility.

The subject, considering its importance, is one that has been greatly neglected by gynaecologists, and it has been left to sexual psychologists like Krafft-Ebing and Havelock Ellis to present the subject in a somewhat unattractive form.

It appears strange that women should not definitely be freed from the psychological stigma of menstruation, or be forced to accept the fact that menstruation may produce mental disturbances which render them unfitted for those strenuous masculine occupations which require well-balanced mental judgments. Many women, of course, are unaffected mentally by the occurrence of menstruation; many are affected in a minor, and some in a major degree. From a social and medico-legal point of view the matter is of considerable importance. In the present day when women are claiming so much for themselves it is very difficult to get at the truth of matters, for women engaged in scientific pursuits spend much of their time trying to convince the public that the psychological and physical economies of women differ not at all from those of men. Statistics are produced to prove this contention; but in all these statistics the ready acceptance of the patient's statement is noteworthy; yet we know how unreliable are personal confessions when the mental condition is challenged. It is difficult, however, to discuss the matter in general terms, so we will proceed to the particular.

The minor degrees of psychological disturbance are seen in mental depression, vacillation or timidity. What is often ascribed to carelessness in breaking crockery or forgetfulness of orders in servants may be due to inattention brought about by menstruation; and with this inattention are associated mental irritability, dullness

¹ H. König, *Berl. klin. Woch.*, 1912, vol. lxi. p. 1645.

of perception and imperfect judgments, which are often accompanied by a feeling of physical exhaustion.

The major psychoses may rarely be represented by temporary insanities, of which König¹ states the more common forms are the maniacal, the melancholic and the hallucinatory. More frequently the patient suffers either with severe mental depression or with kleptomania. Sometimes a patient may be a kleptomaniac without showing any other definite psychical disturbance.

The etiology of menstrual psychoses of a cyclical nature is imperfectly understood. There is no doubt, of course, that they are either due to temporarily disordered metabolism or to the circulation of what may be called 'toxins' in the blood. But these are very general terms. In view of the influence of the endocritic organs on the psychical condition of every one, normal and abnormal, it is not improbable that disturbances in the thyroid and other organs of internal secretion may play a large part in the causation. Indeed, in cases of great mental depression during menstruation we have usually found thyroid extract to be most beneficial.

The medico-legal point of view, especially in regard to kleptomania, is of great importance; on the one hand, lest an irresponsible person be unjustly punished, and, on the other, lest advantage may be taken of the difficulty in defining the extent of the influence of menstruation. No harm would accrue from treating women accused of criminal acts committed at this time in the same way as those of tender age are treated when detected breaking the law.

An interesting discussion on this subject took place at the Annual Meeting of the British Medical Association in 1900. Among other important statements was that of W. Wynn Westcott,² a London coroner of large experience, who said that out of over 200 inquests on female suicides "the majority of these women had killed themselves about the change of life, and of the younger women the majority appeared to have been menstruating at the time of suicide."

A careful investigation—biochemical and physical—should be made of every case in an endeavour to discover evidence which will suggest lines of treatment.

II. *Psychoses associated with Menstrual Disorders.*—This subject has recently been discussed by a joint meeting of the Gynaecological and Psychological Sections of the Royal Society of Medicine;³ and although Ewart, opening the discussion from the psychological point of view, favoured the existence of true amenorrhoeal insanity, the general opinion, expressed by both gynaecologists and alienists, was that amenorrhoea is a concomitant of insanity rather than a causal factor in the disease. We

¹ H. König, *Berl. klin. Woch.*, 1912, vol. lxix. p. 1645.

² W. Wynn Westcott, *Brit. Med. Journ.*, 1900, vol. ii. p. 792.

³ C. T. Ewart and others, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1911, vol. v. p. 81.

have already referred to this when discussing amenorrhoea. So, too, it may be said that while dysmenorrhoea and menorrhagia may aggravate mental disturbances there is no evidence that they initiate them.

It has been found that when the mental disturbance is accentuated by menstrual disorders the patient has a definite psychopathic family history in about 82 per cent of all cases.

Menstrual Neuroses.¹—There is little doubt that apparently normal menstruation may initiate neuroses; but, as a rule, it is disorders of menstruation, especially dysmenorrhoea, which give rise to what are known as 'functional' disturbances.

When normal menstruation causes neuroses, it is our experience that the neuro-pathic conditions are cyclical and only exist in relation to menstruation; and that they are usually most acute just before and for the first two days of the flow.

The disturbances most commonly seen are neuralgias in the face and limbs, headaches, giddiness and muscular weakness. As a rule, there is some slight psychopathic condition associated with these symptoms.

With dysmenorrhoea the general pains and muscular weakness may be very great. Menorrhagia may give rise to headaches and occasionally to neuralgias; frequently, however, especially when the patient rests during the period, there may be none of these symptoms with menorrhagia but only great lassitude. This often leads to invalidism, especially in young girls who are petted and spoilt when suffering with menorrhagia at puberty.

Amenorrhoea itself probably does not give rise to neuroses, although the condition causing the amenorrhoea may do so.

The etiology of these functional lesions appears to be twofold. Those which occur during apparently normal menstruation, or are associated with dysmenorrhoea, are probably metabolic or 'toxic' in origin, while those which are produced by menorrhagia are due to the effect of the excessive losses of blood on the system.

The treatment of cases associated with dysmenorrhoea and menorrhagia consists in curing the menstrual disorder. When associated with normal menstruation the treatment of the neurosis is more difficult. A careful examination of each case should be carried out—not infrequently the metabolism of calcium and nitrogen is found to be deranged—and the treatment based on scientific grounds.

IV. THE MENOPAUSE AND THE DERANGEMENTS ASSOCIATED THEREWITH

It is necessary in the first place to define what is meant by the menopause. Strictly speaking, the word implies the cessation of the menstrual flow, but this is not what

¹ See also *Neuroses of Puberty*, p. 301.

the word in the usual sense is held to mean. It is obvious, for instance, that we may have a permanent cessation of menstruation after the removal of the uterus without the immediate onset of signs and symptoms of the menopause. We shall therefore consider the menopause in the accepted sense which includes not only the cessation of menstruation but also the retrogression of the ovarian functions, together with the associated changes which occur in the whole organism.

How expedient it is that we should only consider the menopause from this more comprehensive point of view is readily realized when we attempt to classify the subject for the sake of description and discussion. We are then at once confronted by those cases in which permanent secondary amenorrhoea has resulted from general disturbances, but in which the other characteristics of the physiological menopause are absent. Such cases we have already considered under the heading of 'Permanent Secondary Amenorrhoea.' Moreover, even under apparently normal conditions the menopause does not necessarily coincide with the cessation of the menses, as is proved by the fact that women have conceived at a fairly advanced age many years after the cessation of menstruation.¹ What was considered a miracle in the case of Sarah may have been a perfectly natural physiological event, even if one of some rarity. We shall have more to say on this point later.

Since the manifestations of the pathologically produced menopause are similar in character, if not in degree, to those associated with the physiological, we shall, in order to avoid repetition, consider the physiological menopause first.

Disorders of the Physiological Menopause

Although the phenomena of the normal menopause have been described in detail elsewhere (p. 81), it is somewhat difficult to say where the normal ends and the abnormal begins. Briefly, it may be stated that the phenomena of the normal menopause consist of atrophic changes in the genitalia of a very gradual character, associated with changes in certain, if not in all, of the other endocrine organs, possibly in response to the cessation of the ovarian functions. These changes lead to metabolic alterations which should, normally, be so gradual that no symptoms are produced. The whole occurrence, then, consists of local atrophy with a general readjustment of the metabolism. With the normal physiological menopause we are not further concerned here, but we must consider the physiological menopause—

¹ L. Buckle, *Journ. Amer. Med. Assoc.*, 1910, vol. xlv. p. 568; R. G. Hann, *Journ. Obstet. and Gyn. British Empire*, 1902, vol. ii. p. 290 (with references); C. Jacobs, *Progrès Médical Belge*, 1909, vol. i. p. 153.

that is to say, the menopause brought about by physiological factors only—in so far as it may be *premature*, *delayed*, or *associated with disturbing symptoms*.

The Premature Menopause.—The normal age for the menopause to supervene in this country is probably between 43 and 48 years of age; and, in any given case, the time of onset is no doubt dependent partly on the age at which menstruation commenced, and partly on the number of children the woman has borne. But behind these factors there are the more essential ones of the physical and physiological constitution of the patient, which are frequently due to the influence of heredity. Should the menopause supervene before the age of 42 years, it may be considered premature. Fiebag,¹ however, considers the menopause premature if it occur before the age of 45 years. But as 163 out of 925 of the cases investigated by him were premature in that sense, it is quite obvious that this writer has placed the normal average age too late. It is to be noted that confusion has sometimes arisen in fixing the date of the menopause owing to the different periods of time covered by the menopausal changes. Fiebag estimates the date from the cessation of menstruation. Some writers calculate from the age at which symptoms commence. The former is the better method.

On an investigation of a case of premature menopause several features immediately present themselves. Firstly, it will be found that menstruation has always, or for some long time, been somewhat scanty—that is to say, there has been primary genital under-activity, or this condition has resulted from some subsequent disturbance. Secondly, the patient is usually fat, sometimes enormously so. This adiposity suggests thyroid or pituitary insufficiency which may be associated with ovarian insufficiency, and consequently sometimes with an inactive and somewhat under-developed uterus. Completely to understand the reaction of the various internal secretions on one another, and on the genital functions, a study must be made of the recent work on the subject.² It is sufficient here to state the facts, and to point out that the minor irregularities of the internal secretions are probably of as great clinical importance as the major disturbances which are perhaps more obvious, and have, therefore, been more fully studied. Thirdly, these patients, when questioned, generally state that they have not possessed any great degree of sexual feeling; in fact, many have been entirely devoid of it. This indicates a low degree of genital activity. Fourthly, the subjects of premature physiological menopause have rarely borne a child or children, unless the conditions

¹ F. Fiebag, Dissert. Breslau, 1911, quoted in *Brit. Med. Journ. Epit.*, 1911, vol. ii. p. 63.

² W. Blair Bell, Arris and Gale Lectures, *Lancet*, 1913, vol. i. pp. 809, 937; *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47; *The Sex Complex*, 1916; A. Biedl, *Innere Sekretion*, Wien, 1913; Harvey Cushing, *The Pituitary Body and its Disorders*, 1912.

leading up to it have been secondary. Fiebag,¹ however, contrary to the experience of most authorities, states that multiparity late in the reproductive period—that is to say, between the ages of 35 and 40 years—predisposes to a premature menopause.

With the premature menopause the symptoms are usually slight, for the patient has for a long period been subject to genital insufficiency; consequently the transition from this condition to the complete cessation of function may be hardly perceptible to her. Indeed, the absence of menstruation is often the only indication of a change from the previous state.

Treatment is usually not called for; and if the patient seek advice it will generally be on account of progressive adiposity. This may be checked by small doses of ovarian and thyroid or pituitary extracts combined.

Delayed Menopause.—Should the menstrual function continue after the patient is fifty years of age the menopause may be said to be delayed.

Delay in the onset of the physiological menopause may result from an exactly opposite series of conditions to those described in connexion with the premature menopause—that is to say, there may be great activity of the genital functions not only in regard to the ovaries and uterus, but possibly also in respect to the thyroid and other endocrine organs in their associations with the genital functions.

These patients are usually thin and active; their sexual feelings have been well developed, and they have usually had children. The statement of Fiebag,¹ already mentioned, that women, especially multiparae, who bear children between the ages of 35 and 40 years have the menopause early, is contrary to the experience of others. In the majority of cases of delayed menopause, when the change of life does eventually supervene, the symptoms are somewhat violent and the period of change is protracted. These phenomena will be discussed later.

The occurrence of menstrual bleeding past the usual period demands careful investigation lest there be some serious pathological condition in the genitalia leading to the continuation of menstruation, and possibly to irregular haemorrhages. Malignant disease of the uterus, fibromyomata, adenomatous polypi and 'fibrosis uteri' must all be excluded. With regard to 'fibrosis uteri' it must not be forgotten that fibrosis occurs normally at this period of life, consequently the symptoms of the condition known as 'fibrosis uteri' may be accentuated then.

Further, it is always necessary to exclude such general diseases as those connected with the circulatory system and kidneys, which may be associated with increased menstruation and delay in the onset of the menopause.

Serious Disturbances of the Physiological Menopause.—These may be either

¹ F. Fiebag, Dissert. Breslau, 1911, quoted in *Brit. Med. Journ. Epit.*, 1911, vol. ii. p. 63.

general or local. The severity of the phenomena is frequently said to depend on the temperament of the patient; but it is possible to express this idea more scientifically, since we know that temperament and the tendency to neurosis are to a considerable extent under the influence of the internal secretions. We recognize, therefore, in women with active ovarian functions the type which comes late to the change of life, and in which violent disturbances may occur as the result of the cessation of ovarian activity. It is not the temperament, then, which governs function so much as it is function that controls temperament.

A. *General Disturbances*.—The phenomena which produce the most acute general disturbances at the menopause are dependent upon the changes in the vaso-motor system in all its ramifications. It has long been known that there is vaso-motor instability at the menopause, and recently Hoskins and Wheelon¹ have shown experimentally that in animals oöphorectomy is followed in a few weeks by increased excitability in the sympathetic system. They accept the view that this is due to disturbance of the calcium metabolism.

The symptoms produced are either visceral or cutaneous.

I. *Vaso-motor Disturbances*.—(a) *Visceral symptoms* are most frequent in connexion with the heart, the digestive tract and the brain. Cardiac distress associated with palpitation and breathlessness is common; more rarely an irregular and intermittent pulse may be observed. When the splanchnics of the digestive tract are affected the patient may suffer with dilatation of the stomach, flatulence and constipation. Sometimes there is polyuria which is probably produced by vaso-dilatation of the renal vessels. Usually during the dilatation stage the head throbs, and sometimes the woman expresses her sensations by saying that she feels “as if her head would burst”; and the pulsation in the vessels may give rise to noises in the ears. Occasionally the patient suffers with severe headache.

(b) *Cutaneous Symptoms*.—The superficial vessels are at all times subject to rapid and frequent changes according to the atmospheric temperature and other influences. At the menopause these changes not only occur as at other times, but they are then more rapid and violent, and may even take place independently of the usual influences. These sudden variations give rise to what are commonly known as ‘flushings’ and ‘cold sweats’: the arterioles dilate and the patient says she feels “hot all over;” contraction follows and she feels chilly.

The treatment of cutaneous vaso-motor disturbances is what is most commonly demanded in the management of the menopause.

Since vaso-dilatation is the prime cause of the symptoms we must direct our

¹ R. G. Hoskins and H. Wheelon, *Amer. Journ. Physiol.*, 1914, vol. xxxv. p. 119.

attention to controlling the blood pressure. If we can keep this steady and high with such preparations as infundibulin, the flushings cease; but this is not easy to accomplish, for as soon as the effect of one dose wears off vaso-dilatation occurs. We have found that the best results are obtained by the administration of calcium salts as well as the pituitary extract.¹

Should there be polyuria, pituitary extract would be contra-indicated, for according to Schäfer and Magnus² this preparation causes specific dilatation of the renal vessels. Whether this be the true cause or not, infundibulin is undoubtedly a diuretic. Further, it is most important to regulate the bowels; there is often marked constipation which leads to auto-intoxication. Liquid paraffin is probably the most useful laxative in these cases, after the bowels have been freely purged with calomel for a few days previously.

II. *Menopausal Psychoses*.—The 'change of life' is anticipated by the majority of women with fear. In the first place they look upon this period as synchronous with the disappearance of their feminine attractions: youth, beauty and charm, and all that makes them desirable to men. We need not here discuss how far this may be true; it is sufficient to know that this idea presents itself to most women as the time draws near. Further, many are under the impression that insanity is a frequent concomitant of the menopause. These ideas naturally tend to disturb the patient, but in most cases all that is necessary is to assure her that such fears are unfounded. Nevertheless, we occasionally see a complete mental change: the patient becomes melancholic and suspicious. As a rule, careful management and suggestion will tide over the period of uncertainty. If, however, a woman has a strong psychopathic tendency she may become insane. Melancholia, with ideas of persecution, is the most common form. All cases of mental depression should be given thyroid extract in small doses, in addition to any other treatment deemed necessary. It is not uncommon for the normal sexual feelings of women at the menopause to become accentuated.

III. *Menopausal Neuroses*.—Local neuroses are not uncommon. Neuralgias, functional paralysis and contractures, hyperaesthesias and sleeplessness may be met with, and are sometimes most difficult to alleviate. Massage and auto-suggestion are probably the most useful methods of treatment in severe cases. Sedatives and alcohol should be avoided. General specific treatment of the nervous disorders of the menopause is impossible until we are aware of the exact etiological factors concerned. Bromides have been extensively prescribed, but in our opinion they are almost valueless, if not actually harmful.

¹ W. Blair Bell, *Liverpool Med. Chir. Journ.*, 1912, vol. xxxii. p. 398.

² E. A. Schäfer and R. Magnus, *Journ. Physiol.*, 1901, vol. xxvii. p. 9.

Careful attention to the state of the bowels ; as much fresh air and exercise as possible, together with moderate occupation and company, are essential. Valerian, strychnine, thyroid, or thyroid and ovarian extracts combined, with relief of special symptoms, will assist us in the majority of cases to tide the patient over the period of stress.

IV. *Disorders of the Endocritic Glands.*—With the cessation of the ovarian functions changes occur in the correlated organs of internal secretion. Since women at the menopause have passed the stage of growth and reproduction (with rare exceptions) the changes either are not marked or do not give rise to symptoms, except in the case of disturbance of the thyroid. In the physiological menopause the thyroid undergoes atrophic changes with interstitial fibrosis. In the majority of cases the atrophy does not exceed the degree of function still required in the altered circumstances, consequently no symptoms are produced. In a certain number of cases, however, as already indicated, there is thyroid insufficiency. An irregular thyroid secretion may directly and indirectly produce many of the vaso-motor symptoms seen at this time of life, while definite insufficiency leads to obesity and mental depression. Further, the degree of atrophy may be so great that myxoedema is produced—indeed,* this disease usually occurs in women (the sex ratio being 6 to 1, according to Osler),¹ and at or after the menopause. Rarely, exophthalmic goitre may supervene. This is probably due to an extreme effort on the part of the thyroid to replace the diminishing ovarian secretion. We have, also, seen temporary enlargement of the pituitary body (pars anterior) with hemianopsia and severe headache.

For a more detailed account of the relation of the ductless glands to the menopause reference should be made to the recent discussion at the Royal Society of Medicine.²

B. *Local Disturbances.*—The normal changes that occur in the genitalia as the result of the physiological menopause have been described elsewhere (p. 83). Atrophic changes in the endometrium and vulva may lead to 'senile endometritis' and kraurosis vulvae. Simple pruritus vulvae, also, is not uncommon. Excessive shrinking of the vagina may give rise to dyspareunia. The chief disturbances of function are, however, related to menstruation and conception.

The menopause may supervene suddenly with permanent amenorrhoea. This is unusual, and when it occurs may lead to very serious general disturbances. It

¹ W. Osler, *Principles and Practice of Medicine*, 1912, p. 875.

² W. Blair Bell and others, Discussion, *Proc. Roy. Soc. Med. (Obstet. and Gyn. Sect.)*, 1913, vol. vii. p. 47 *et seq.*

is usual for the onset to be slow with periods of amenorrhoea gradually increasing in length. The atrophy of the uterus and vagina is correspondingly gradual and never really marked until the complete cessation of the ovarian functions. The vagina, it should be remembered, does not atrophy till very late in life if marital relations be regularly continued.

The decreasing function of conception will be considered in the discussion of 'Sterility' (p. 404).

The Pathological Menopause

By the pathological menopause we refer to the menopause which is produced otherwise than by physiological processes, as already described. The pathological menopause is brought about either by diseases affecting the genitalia directly, or by operative procedures (artificial menopause).

It must be emphasized in connexion with the pathological menopause that the causes, so far as we know, all act locally on the genitalia ; for, as we have already said, permanent secondary amenorrhoea produced by general causes cannot be looked upon as the true menopause.

Superinvolution of the Uterus.—It is probable that this condition is accompanied by some ovarian atrophy, although such a change has not been demonstrated owing to the difficulty of obtaining material. When the case is first seen the uterus is usually found to be quite small—the cavity measuring, perhaps, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length. On bi-manual examination we have been unable to detect any palpable atrophy in the ovaries.

The general symptoms of the menopause may eventually supervene, but they are of a very mild type, and the patient is usually most concerned about the absence of menstruation.

As indicated, the etiology of this condition has never been proved. Some think it is the result of too prolonged lactation, hence the term 'lactation atrophy,' but this is certainly not usually the case. Others have attributed the result to post-partum haemorrhage, which has been a detail in the history of many cases.

But it appears to us that it is probably incorrect to look upon superinvolution as a purely local condition. There is reason to believe that in many cases there is some disturbance of the endocritic organs—the thyroid and pituitary, especially—other than the ovaries. Experimentally we have shown that intense atrophy of the uterus is produced, especially post-partum, by thyroidectomy.

With superinvolution menopausal symptoms appear some time after the cessation of menstruation, so it is possible that the uterus atrophies before the ovaries,

as may occur in the physiological menopause. It is probable that once general menopausal symptoms appear superinvolution is incurable owing to extensive ovarian atrophy. It is, however, impossible to dogmatize at present while our knowledge is so imperfect (see also p. 326).

Destructive Lesions in the Genitalia.—Destructive lesions may affect either the ovaries or uterus, and produce the menopause.

In regard to the uterus we shall have more to say concerning its influence over sexual activity when dealing with operative procedures and the menopause. It is sufficient here to say that complete destruction of this organ with the continuation of life and health is not possible except only as the result of severe puerperal infections with sloughing of the endometrium, or as the after-effect of some barbaric operation, such as atmokausis. In these cases the uterus may become a fibrous mass. It is probable, too, that the use of radium for menorrhagia will in some cases lead to permanent destruction of the endometrium. Following the cessation of the uterine function ovarian atrophy may eventually occur and produce the menopause. Destructive lesions of the ovary producing the menopause are very rare. Malignant growths may destroy the normal tissue, but usually the disease is then in such an advanced state that a fatal termination rapidly supervenes. Acute infections of both ovaries with suppuration may lead to the destruction of all healthy ovarian tissue and give rise to the menopause. Usually, however, sufficient normal tissue is left to prevent this occurring. Sometimes ovarian cysts lead to permanent amenorrhoea, but it is extremely rare to see other menopausal phenomena associated therewith. Röntgen rays applied to the ovarian regions, either by accident or intentionally, are capable of destroying the ovarian secretory cells, and so of causing the menopause to supervene.

Radical Operative Procedures.—These may relate to the uterus or ovaries, or to the uterus and ovaries together. It will be worth while briefly to consider each separately.

I. Removal of Ovaries (Oöphorectomy).—Opinions vary widely as to the evil effects produced by oöphorectomy. Some operators believe that a 'clean sweep,' as they call it, is infinitely preferable to leaving an ovary behind, especially in the presence of an infection. These operators assert that no evil results follow oöphorectomy.

It appears probable, however, that in a large number of cases no serious effects would result, even if the operation were complete, and the menopause supervened. The reasons of this are not difficult to appreciate: very frequently, especially in the case of infections, the ovary has already been damaged and its secretion reduced, consequently the loss is not so great as in the case of a normal organ. Further, the

patient is often over thirty-five years of age ; and this is a matter of some importance, for the nearer the age of the patient is to that of the natural menopause the less will she suffer from the artificial, because the functions of the ovary are lessened as the period of the menopause approaches. Lastly, there is the question of the patient herself. There is no doubt that ovarian activity differs in different individuals : in the adipose, slow-witted patient with scanty menstruation the ovaries are not very active, and may be removed without provoking violent symptoms ; whereas in the thinner, energetic, profusely menstruating subject removal of the ovaries will often cause mental and physical disaster.

To sum up, then : the explanation of the different results which may follow oöphorectomy are to be found in the age, in the degree of ovarian disease and in the normal ovarian activity of any given patient.

Hence the symptoms that may supervene on oöphorectomy vary from the mildest inconveniences, such as occasional 'flushings,' to the most serious mental and physical disturbances of the menopause, as already recounted.

II. *Complete Removal of Ovaries and Uterus (Hystero-salpingo-oöphorectomy).*—This procedure is by most operators only adopted when there is malignant disease of the uterus, the ovaries or vagina : it is an essential undertaking for a radical operation.

As a rule, the patient is about the menopause, so she does not suffer with serious menopausal symptoms. But if the procedure be adopted in a young subject with active functions the direst consequences may ensue. We remember one case in which an angiomatous fibromyomatous uterus in a woman about thirty years of age was removed completely with the ovaries in the belief that the growth in the uterus was sarcomatous. For years the patient suffered from most violent symptoms which were with difficulty controlled. On the other hand, we have removed the uterus and ovaries from a patient under thirty-five years of age for carcinoma of the cervix without producing any menopausal symptoms. In this case, however, the patient was extremely fat, lethargic and had scanty menstruation.

We do not agree with the principle of the 'clean sweep' in operations for fibromyomata, at any rate unless one can accurately gauge the genital activity of the patient on the lines indicated above.

III. *Removal of the Uterus (Hysterectomy).*—It is not generally realized that complete removal of the uterus without oöphorectomy may give rise to symptoms of the climacteric, either immediately or by inducing a premature menopause. In these circumstances the menopausal symptoms are mild and are physical in character—'flushings,' palpitation and other vaso-motor phenomena—without psychical disturbances.

That the menopause only rarely supervenes immediately after the removal of the uterus is too obvious to all operators to need further discussion, but there is no doubt that after removal of the uterus the menopause occurs earlier, and usually in much quieter a fashion than in ordinary circumstances. We have always held that the uterus plays a more important part in menstruation and in the integrity of the ovarian function than is usually accepted, and there can be little doubt, if the above observations be correct, that this is so.

Zweifel and Abel, quoted by Doran,¹ recognizing the relation of the uterus to the ovaries, advocated the conservation of some part of the endometrium in operations for innocent growths of the uterus, infections and, in fact, for any but malignant disease. They state that the presence of the endometrium prevents atrophy of the ovaries, which they believe to occur sooner or later as a direct consequence of complete hysterectomy.

We are entirely in accord with these views, and in women under forty years of age make a practice whenever possible of leaving a small portion of the endometrium, above the internal os, from which menstruation will occur regularly.

We can recall the case of one patient, now forty-seven years of age, who is still menstruating normally nine years after the removal of the uterus for fibromyomata with conservation of a small area of endometrium. It is possible to treat the majority of cases in this way.

The advantage to the patient is enormous; her functions are in no way interfered with, and in the presence of menstruation she has no fear of 'the change of life,' which we have known to depress many patients from whom the body of the uterus has been completely removed. A woman often considers that with the cessation of menstruation the climacteric is bound to supervene—as indeed it does sooner than normally; in fact, most women interpret the menopause literally, and not in the scientific sense already discussed.

It is stated that women will menstruate from the cervix. We have only met with one such case, already mentioned, in which we were compelled to remove the cervix subsequently owing to severe menorrhagia.

It is only right to point out that the statements made concerning ovarian atrophy after hysterectomy have no experimental support. This, however, may be due to the short time that has intervened between the operation and the examination of the ovaries; also because the actual menopause in the lower animals has not been properly observed. We ourselves had a bitch from birth until she was

¹ Zweifel and Abel, quoted by Alban Doran, *Trans. Obstet. Soc.*, London, 1905, vol. xlvii. p. 363.

mercifully destroyed at the age of seventeen years—extreme old age for a dog—who came on heat more or less regularly till the end of her life.

Treatment.—It is not necessary to discuss further the treatment of cases due to superinvolution and destructive lesions; but the menopause following operative treatment deserves special attention. We need not, however, consider the treatment of the ordinary symptoms—that has been done in connexion with the



FIG. 175.—Section of heterogeneous ovarian graft implanted in the human uterus, showing the muscle-fibres of the uterus enclosing the graft which is undergoing necrosis. ($\times 60$.)

physiological menopause—but rather the methods used to overcome the whole phenomenon after the removal of the essential organs.

Ovarian Transplantation.—Of recent years this procedure has been practised, but somewhat spasmodically, and apart from the work of Tuffier of Paris¹ no large number of cases has been recorded. This method of treatment only applies, of course, to patients in whom oöphorectomy has been performed before the menopause.

In the first place it is well to emphasize the fact that transplantation can only

¹ T. Tuffier, *Surg., Gyn. and Obstet.*, 1915, vol. xx. p. 30.

be required in extremely few cases. In all but those of malignant disease careful operative technique usually enables us to preserve some portion of one or other ovary; while in malignant disease it is quite clear it would be wrong to transplant any portion of an organ which may contain cancer cells. Further, in these cases the woman is usually about or past the physiological menopause. It will be quite evident how restricted, therefore, is the field in which transplantation can or should be employed, especially when we add to the above statements the requirement that



FIG. 176.—Section of autogenous graft of ovarian interstitial cells five weeks after implantation in the muscles of the abdominal wall of a rabbit, showing the normal interstitial cells among muscle-fibres and fibrous tissue. The integrity of the uterus was unimpaired. ($\times 250$.)

the ovarian grafts must be autogenous; for, in the human subject heterogeneous grafts almost always perish (Fig. 175).

When a transplantation is carried out it is best to use a wedge-shaped piece, not more than a quarter of an inch in thickness, from the centre of the ovary. Tuffier simply buries in the abdominal wall a complete ovary after its removal. The disadvantages attending this procedure are: firstly, such a large mass of ovarian tissue without raw surfaces cannot be properly vascularized; secondly, if it were to be partially vascularized pain and swelling might be caused by the ripening

Graafian follicles which would be unable to rupture owing to the encapsulation of the ovary. Thirdly, the unruptured follicles would form cysts. These disadvantages are said to be frequently seen if the whole ovary be implanted.

If, however, a thin portion of ovary, without the follicles in the cortex, be employed the uterus will continue its normal activity in spite of the absence of Graafian follicles. We have recently tested this matter experimentally, and have found that an autogenous graft of interstitial cells alone from a rabbit's ovary (Fig. 176), which are easily isolated, is capable of maintaining the activity of the uterus.

Transplantation may be made anywhere, but the more vascular the tissue the better. The plan we have usually adopted is partially to bury the wedge-shaped piece of ovary in the fundus uteri (Figs. 177, 178). If the surface be uncovered it is unnecessary to remove the cortex which contains the Graafian follicles.

Autogenous transplantations certainly do postpone and mitigate the menopause, even if they fail to re-establish menstruation; but we do not think it is long deferred.

Prepared-hormone therapy may be of advantage in women under forty years of age from whom the ovaries have been removed for malignant disease or for some other cause. We do not think that luteal extract possesses any special advantage over ordinary ovarian extract. Indeed, we think the interstitial cells of the ovary are of the greater importance, as we have already indicated. But neither of these ovarian extracts is reliable when employed alone. We have found that ovarian combined with thyroid extract gives the best and most constant results. Five to ten grains of ovarian extract should be given three times a day with meals, together with a dose of one grain or more of thyroid extract when the patient goes to bed at night.

In an attempt to save the ovaries after hysterectomy we have employed an extract of the endometrium, but it is extremely difficult to trace its value over the long period of observation necessary, and hard to get the patient to take the preparation in the absence of symptoms. It should be tried, however, in those somewhat rare cases in which menopausal symptoms immediately supervene on simple hysterectomy. Testicular extract sometimes appears to have a beneficial effect in mitigating the vaso-motor and psychical phenomena which may be associated with the menopause, but the *modus operandi* is difficult to understand. We have not used this preparation often, but we can recall to mind one patient who stated that she had received considerable relief from this treatment, and others who derived no benefit therefrom.

General Treatment.—This is the same as that described for the disturbances of the physiological menopause. The symptoms are mitigated as far as possible, until such time as readjustment may have taken place.

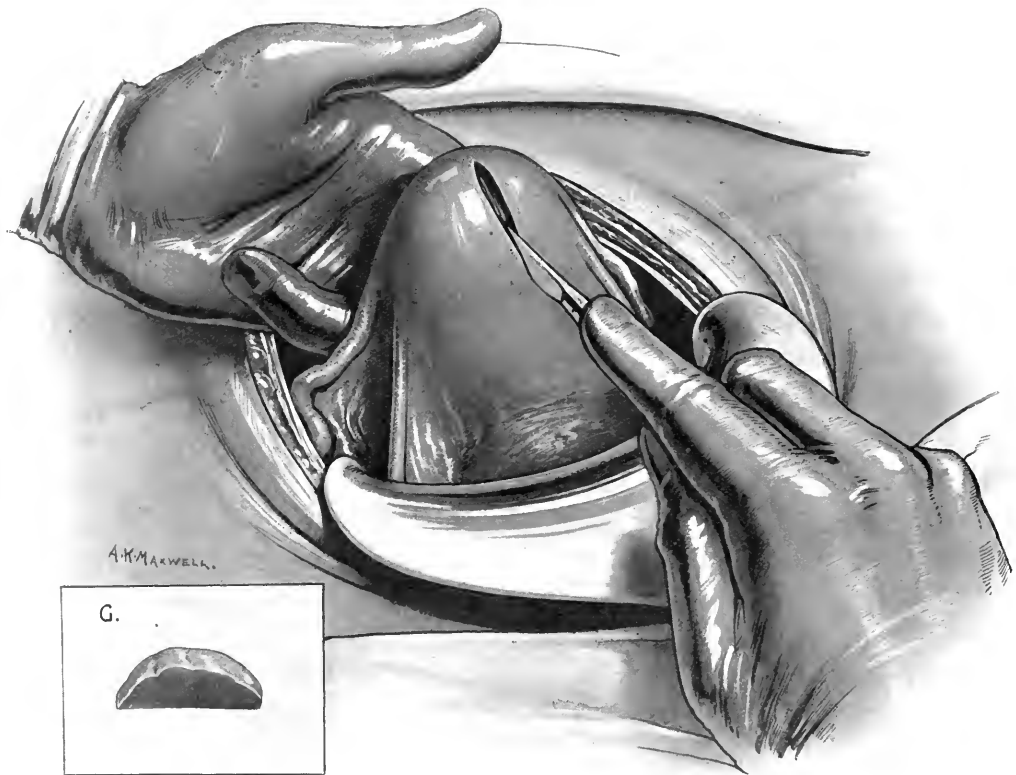


FIG. 177.—Author's method of implanting an ovarian graft in the human uterus. In the main drawing the making of the incision is illustrated, and in inset (G) is shown the wedge-shaped ovarian graft.

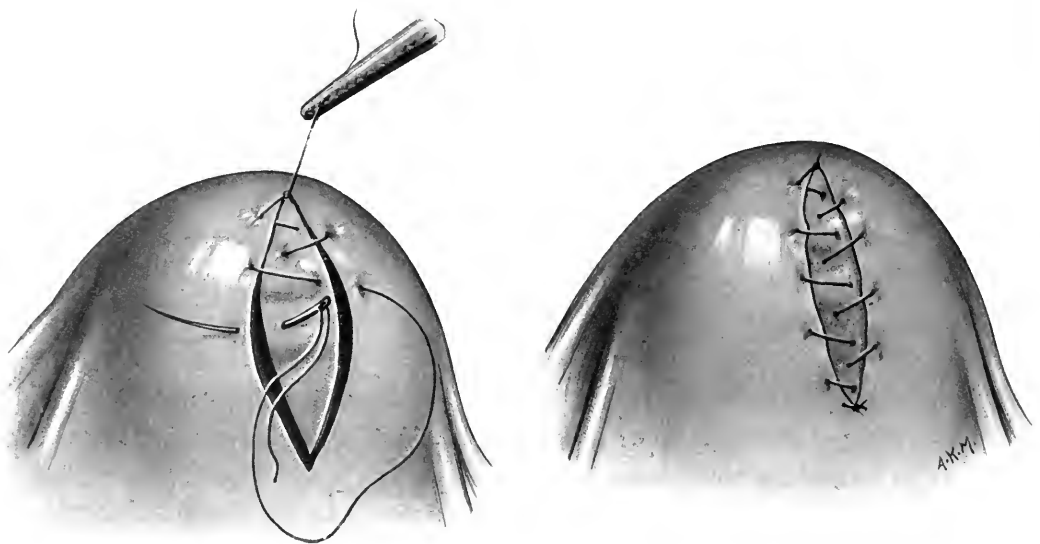


FIG. 178.—Author's method of implanting an ovarian graft in the human uterus. The way in which the graft is sutured in position with fine catgut is illustrated.

PART II

DERANGEMENTS OF THE SEXUAL FUNCTIONS AND OF CONCEPTION

I. DERANGEMENTS OF THE SEXUAL FUNCTIONS

Derangements of the sexual functions may be due either to physical or to psychical anomalies.

Physical Anomalies

Apareunia.—We have coined this word, which implies *impossibility* of coitus, to cover a class of cases not properly included in the term ‘dyspareunia,’ which means *difficulty* in coitus.

As with sterility the fault may lie with the husband, who, from some malformation of the penis or other cause, is unable to effect the sexual act; but here we are only concerned with anomalies in the female.

The causes of apareunia, then, are those which either absolutely prevent penetration of the vagina or prevent access to the vaginal orifice.

A. *Impermeability of the vagina* may be due to :

- (1) *Abnormal hymen*, which may be imperforate, cribriform or unusually tough.
- (2) *Imperforate vagina*, which may be developmental or acquired (new growths and infections).
- (3) *Absence of vagina*, congenital or from operative procedures. We might also consider that complete procidentia and inversion come within this category.
- (4) *Senile atrophy of vagina*.

B. *Impossibility of access to the vaginal orifice* may be due to :

- (1) *Malformations*, such as accessory lower limbs and united twins.
- (2) *Acquired deformities*, such as bilateral ankylosis of the hip-joints or spastic paraplegia producing the ‘scissor-leg’ deformity.

It is quite clear that cases in the ‘B’ group are not marriageable in the legal sense of the word, unless more or less serious operations be first successfully undertaken. In the first group many of the conditions are curable : thus, any abnormality of the hymen and most imperforate conditions of the vagina are very easily remedied by minor operative procedures. Even the congenital absence of a vagina need not at the present time prove a barrier to marriage, for an artificial one can be made.

This is usually effected by utilizing an isolated loop of small intestine which is fixed in a passage made between the bladder and rectum. Details of all the procedures necessary for dealing with these conditions are dealt with elsewhere in this work.

Dyspareunia.—Difficulty of coitus, as clearly distinct from impossibility, must always be associated with pain; indeed, it is often the pain which prevents the completion of the sexual act, rather than that there is any mechanical difficulty. In some cases the sexual act is accomplished, but with difficulty and pain.

As we shall see presently, the difficulty and pain are sometimes augmented, if the act be persisted in, by a spasm of the muscles surrounding the vagina; this is known as 'vaginismus.' Once produced, this condition may exist long after any real cause for its protective interference has ceased to exist. Vaginismus, then, is a purely nervous phenomenon, and is rarely seen in women who have previously had painless connexion. We shall discuss it in detail directly.

Clinically, dyspareunia is best considered from two standpoints: that seen in young married women who have never had painless sexual intercourse (*primary dyspareunia*), and that seen in women in whom coitus has previously been painless (*secondary dyspareunia*).

A. *Primary Dyspareunia.*—This may be due to the following causes:

- (1) *Clumsiness or inexperience on the part of the man.*
- (2) *Fear of being hurt*, after a first painful attempt at coitus.
- (3) *Tender carunculae myrtiformes or soreness from laceration of the hymen.*
- (4) *Disproportion in size between the male organ and the ostium vaginae.*

—This is especially common when spinsters marry after the menopause, and in maldevelopments of the vagina.

- (5) *Prolapsed ovaries.*
- (6) *Infections of the tubes and ovaries* from appendicitis or tuberculous lesions.
- (7) *Growths of the vulva or vagina.*

When the genitalia of the man and woman are normal, and the dyspareunia is due to clumsiness on the part of the husband or fear on the part of the wife, reassurance that patience and further gentle attempts at coitus will lead to the perfect consummation of the sexual act will usually be all that is necessary in the way of treatment. At the same time it must not be forgotten that many homes are made miserable by dyspareunia, so when necessary every assistance should be given to ensure satisfactory marital relations, even to the extent to be described directly.

The treatment of primary dyspareunia when there is a definite pathological

lesion, such as pelvic infection, resolves itself into the treatment of the lesion found. When, however, there are tender carunculae myrtiformes or there is a laceration of the hymen that is painful, or the fear of being hurt after the first attempt, it is most important if the case be seen early that proper measures be taken, lest vaginismus supervene and prove an insuperable barrier to penetration. Once there is vaginismus a cure is more difficult. Abstention from coitus must be advised in these circumstances until all soreness has disappeared. On the resumption of marital relations gentleness and care must be employed.

As already indicated, vaginismus may supervene in the above cases as a protective contraction of the sphincter vaginae; but, as the condition may continue subsequently to the existence of any stimulating cause, it will be necessary to consider it separately.

Vaginismus.—The muscles concerned in producing this spasm are the bulbo-cavernosi, the transversi perinei and the levatores ani; and possibly also the sphincter



FIG. 179.—Vaginal glass dilator.

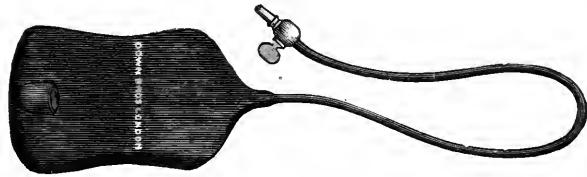


FIG. 180.—Barnes' hydrostatic bag.

ani, which, together with the transversi perinei, fixes the central point of the perineum to which the bulbo-cavernosi are attached. From an originally protective muscular contraction, which resists penetration and the consequent tearing or stretching of tender spots, vaginismus may persist as a nervous manifestation. Indeed, it is said to exist before any lesion has been caused, but this is improbable; it is more likely that in a nervous patient the first feeling of stretching which causes pain leads to a spasm which may become habitual. We have been consulted by ladies who had been married for eleven and twelve years respectively without penetration having been effected. Now the effect of repeated attempts at coitus spread over many years almost invariably produces in the woman a neurasthenic and hysterical condition; consequently the vaginismus may become accentuated rather than lessened as time goes on.

Treatment is difficult in most cases, for there is often a neuropathic tendency in the patient. First of all, stretching of the vaginal outlet may be performed under general anaesthesia. Subsequently, the patient should wear a vaginal glass dilator (Fig. 179) for a few hours each day, while resting on a bed or couch. We have found that sometimes a large size Barnes' bag (Fig. 180) filled with warm water

after the upper end has been inserted through the vaginal orifice is more comfortable. It should be retained in position with a T-bandage.

In many cases, however, the patient either will not tolerate these measures or is not cured by them. In such circumstances the best practice is to incise the

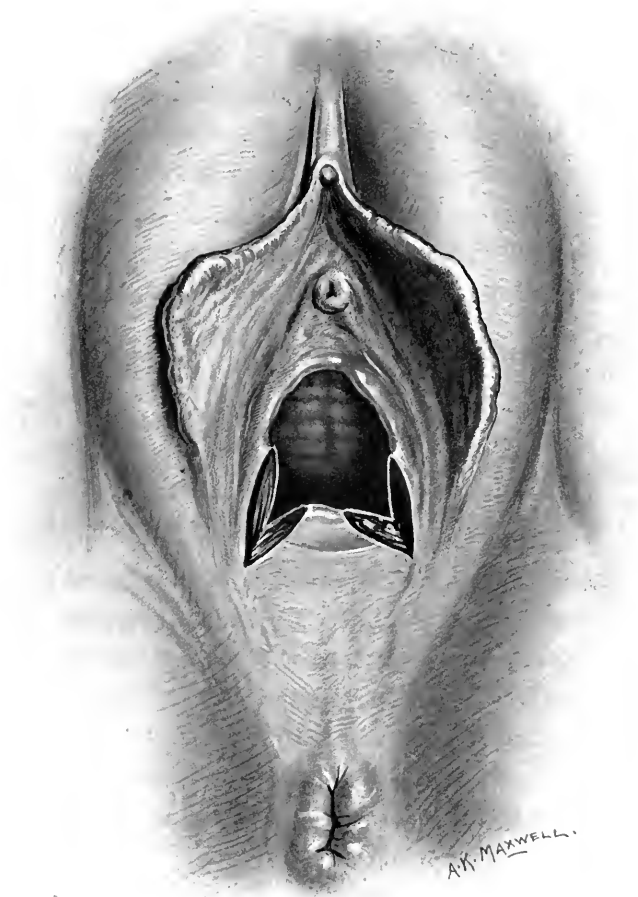


FIG. 181.—Method of enlarging the vaginal orifice, showing the lateral incisions.

vaginal orifice. It is sometimes recommended that this be done in the middle line; but we believe this to be a mistake for two reasons. Firstly, the scar, which is in the situation of greatest pressure, may be tender during subsequent coitus; and, secondly, in parturition there might be resistance to the stretching of the perineum, followed by severe laceration in the line of the scar.

In view of these possibilities it is better to make two incisions, one on each side of the middle line (Fig. 181). They should be carried deeply through the superficial layers of the constricting sphincter. These incisions gape and produce a diamond-shaped raw surface on each side. Next, the skin and vaginal mucosa

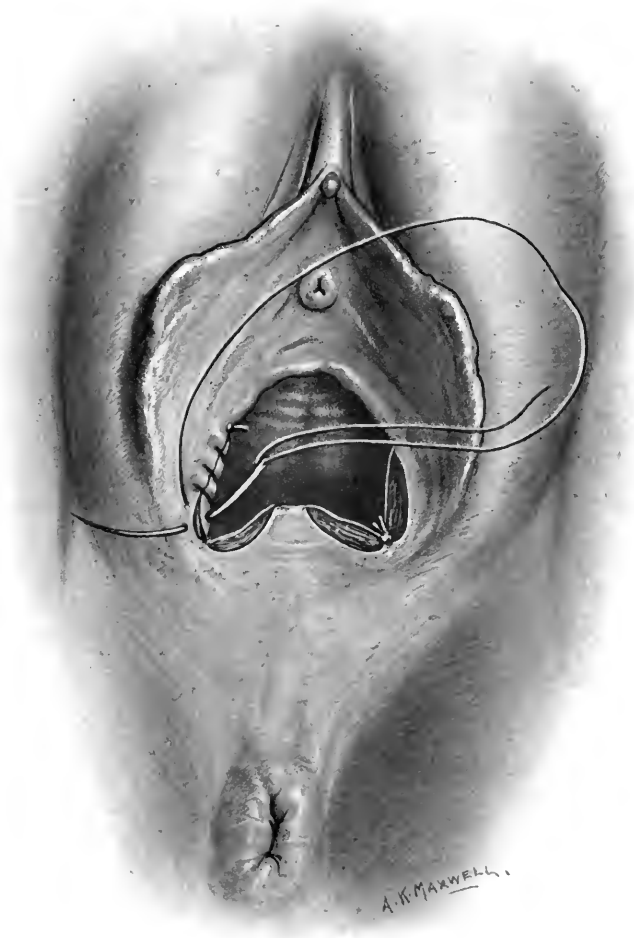


FIG. 182.—Method of enlarging the vaginal orifice, showing the transverse closure of the incisions.

should be sutured transversely with thirty-day chromic catgut, as shown in Fig. 182. in order to increase the circumference of the vaginal orifice (Fig. 183). At the same time any tender carunculae myrtiformes may be excised. During convalescence a large glass dilator should be left in for several hours daily. If properly performed, this operation gives excellent results.

B. *Secondary Dyspareunia*.—This implies that dyspareunia supervenes after years of painless intercourse, and possibly even after parturition. The causes, which are practically always local, may be grouped as follows : (1) *Infections of the vulva, vagina or adnexa* ; (2) *displacements of the fundus uteri and ovaries* ; (3) *new growths*

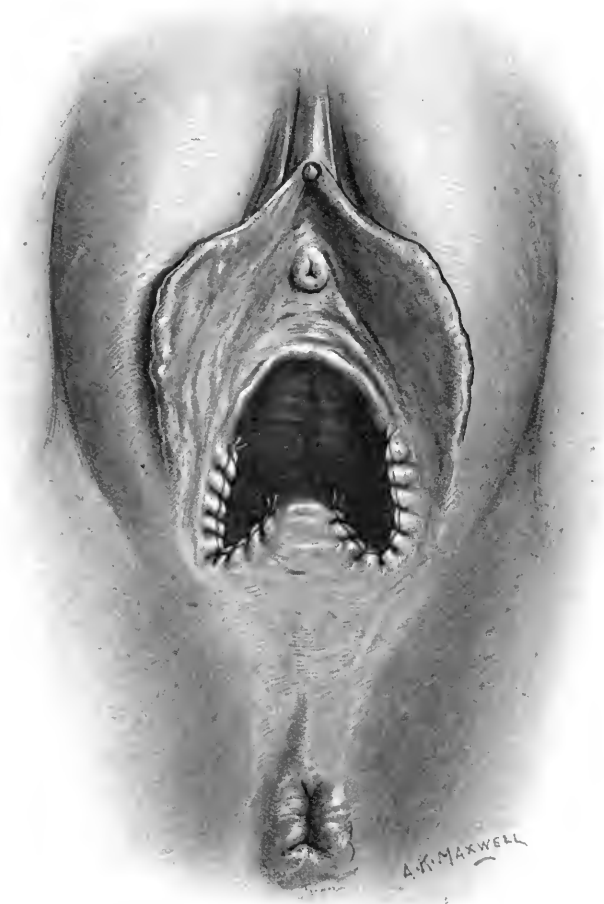


FIG. 183.—Method of enlarging the vaginal orifice, showing the operation completed.

of the vulva, vagina and cervix uteri. It will be evident that the pain is experienced at the site of the lesion. When there is a new growth, such as a caruncle, or an infection involving, for instance, Bartholin's gland, coitus may be impossible owing to the sensitiveness of the condition present. When, however, the lesion is situated above the vagina, as in the case of a prolapsed ovary or salpingitis, the pain

rarely prevents penetration or coitus ; that is to say, pain is often not experienced until the culmination of the act. Vaginismus is very rarely seen with secondary dyspareunia, especially when the lesion present affects the internal genitalia. The treatment of secondary dyspareunia is that of the condition causing it.

Psychoses and Neuroses

Psychical disturbances associated with the menstrual function and the menopause have already been briefly discussed, but it is necessary here to mention abnormalities of the mental attitude toward the sexual act, and the effect of normal and abnormal sexual gratification on the mind.

In the first place it is difficult to establish what may be described as a *normal standard* of the mental attitude towards coitus. Civilization, with its social exigencies supported by religion, has undoubtedly raised an artificial standard ; no one is supposed to be at the mercy of the 'natural instincts,' as the summation of stimuli is called. It is difficult, therefore, to express in words the modern standard. If we consider what are the natural stimuli we find that these are internal and external. The internal stimuli are those that arise from the internal secretions of the endocritic organs, and from the resulting metabolic conditions. The external are those that affect the special senses of sight, smell, hearing and touch. These external stimuli in women, as opposed to animals, give rise to psychical effects which culminate in choice. Further, that 'mental affinity,' so dear to some women, is the result produced in their minds by the mental activities of their partners.

These psychical phenomena which constitute the factors in choice are, so far as we know, peculiar to the human species, and they add considerably to the complexity of the sexual emotions. As we have pointed out elsewhere,¹ whereas the maximum sexual attraction in animals is the result of physical stimuli, in the human species sexual love is often almost as much psychical as physical ; at any rate, it includes stimuli of both characters.

We can, therefore, meet with psychical as well as physical derangements as a result of sexual acts and emotions ; and although a wide latitude in respect to mental normality is allowed we must attempt to define the reasonable limits before mentioning the excursions beyond.

A woman is, in our days, not expected to exhibit any great degree of sexuality, and if she fall a victim to her emotions she becomes an outcast. A woman is not judged by the standard of masculine sexuality. The average man is supposed to be immoral, and undoubtedly he is. A woman, if she have the same feelings, as is often

¹ W. Blair Bell, *Practitioner's Encyclopaedia*, Oxford Med. Press, 1912, p. 966.

the case, either becomes ostracized or may suffer from the restraint imposed. Social exigencies, in fact, establish the relative standards which suit the community best, if not the individual. Fortunately, women as a rule have not the strong sexual emotions of men. Most men are swayed at some period of their youth by sexual passions. Comparatively few women feel imperative sexual desire until they have enjoyed a sexual life for some time. Beyond these estimations of the normal standard we are not prepared to go. The extreme departures therefrom alone demand our consideration.

Deficient Sexuality.—Some women are absolutely passionless and never enjoy sexual intercourse. They are certainly not normal, but it is not always an easy matter to say exactly what the cause is. It may lie in physical anomalies connected with the proper development of the sex characteristics and functions, or it may be connected with the psychical attitude. Hard work, bad living, mental and physical strain may all be concerned in producing this result. In many cases, but by no means in all, the desire for children is absent. Frequently the woman is extremely feminine in type. Sometimes in such women the absence of sexual feeling is due to the fact that the husband fails to stimulate his wife's emotions; and occasionally another man—unfortunately, no doubt, from a moral point of view—is able to do so. But, on the other hand, the woman may be a misandrist and masculine in many of her characteristics and performances.

Limitation of Sexuality.—By this we mean that sexuality may be quite well developed potentially, but owing to the circumstances existing there is no outlet for it. Our social and moral codes prohibit sexual intercourse—a natural instinct,—unless a woman be married—a social restriction. In the result we have a number of women thrown on the community with unsatisfied sexual and maternal instincts. It is true the majority have not the faintest idea what is the matter with them—what is making them restless and peevish. Happily-married women have told us that most healthy and intelligent women recognize that the virgin state in women in whom sexuality is developed may eventually produce the worst physical and mental phenomena, even in those who previously were normal and affectionate.

Psychically, as we have said, after thirty years of age a woman may become restless and peevish, and she may even become hysterical or neurasthenic. As a result of her unsatisfied physiological requirements she either throws herself into some desperate enterprise—suffragism or theosophy—the sophistry of which suits well her mental attitude of vagueness and indefinite desire; or she may drift into a condition of apathy and neurasthenia. It must not, of course, be imagined that all women are so affected.

The physical results may be serious apart from the condition of neurasthenia or hysteria. A woman who is deprived of natural satisfaction and motherhood, although the reason be unknown to her, may suffer from menorrhagia and disturbances of her general metabolism.

Akin to the complete limitation of the sexual functions are two other varieties which may be met with. We refer in the first place to the girl, especially in the lower classes, who is 'engaged' and receives physical endearments without any real sexual gratification. In such circumstances she may suffer mentally and become nervous and irritable or depressed. Physically, as we have already seen (p. 336), she may suffer with menorrhagia and epimenorrhoea. These cases must be treated on common-sense lines.

The second variety referred to in this connexion includes those women who, either from a desire to avoid pregnancy, or because of some physical disability on the part of their husbands or themselves, receive sexual stimulation without complete consummation of the act. Such women become irritable and discontented, and may suffer with menorrhagia, dysmenorrhoea and all manner of neuroses.

Too rarely does the physician enquire into the sexual life of his 'neurotic' patient; if he did so more frequently he would probably give sound advice more often than bromides, and might help these patients, instead of failing so often to relieve them. Freud's¹ well-known views on the relation of 'sexual traumata' to hysteria may be extreme, but there is some truth in this point of view.

Excessive Sexuality.—We have already referred to excessive sexuality at puberty and at the menopause, but it is necessary to allude to the matter briefly here. A woman may be more sexual than the average—we need not enter into the causes, which are very complex—and the result may be manifested in three ways. First, there may be excessive sexual indulgence with its train of neurasthenic symptoms. This is easily curable by the isolation of the patient from her husband, either by temporary separation or by the occupation of separate rooms. Secondly, there may be masturbation or sexual inversion. These practices are not common in married women unless indulged in before matrimony; if so, the woman may be comparatively apathetic to the normal act and prefer abnormal satisfaction. The patient may not suffer at all in health; should she do so the symptoms are those of neurasthenia. Psychotherapy is the most rational form of treatment. Thirdly, there may be actual sexual insanity; but this requires no special discussion here.

¹ S. Freud, *Papers on Hysteria and other Psychoneuroses*, Eng. Trans. by A. A. Brill, New York, 1912.

II. DERANGEMENT OF CONCEPTION

Sterility

Matthews Duncan¹ commenced his classical lectures on sterility in Woman with the following statement: "Sterility is generally considered to imply the condition of a woman who, under ordinary favourable circumstances for reproduction, does not bring forth a living and viable child. But the term is used with many other meanings, and I shall not state a definition, because I have no right or power to enforce adherence to it, and because, meantime, it is indispensable to have the word for various uses; and with the use of appropriate qualifying words ambiguity may be avoided." It is probable that with and without qualifying words 'sterility' will go on bearing different interpretations, as it has done in the past.

We ourselves are inclined to think that this term should only be used to imply *the result produced by those conditions which prevent fertilization and implantation*. Once the ovum has been fertilized by the spermatozoon and implantation has occurred sterility can no longer be said to exist. It is probable, too, that fertilization rarely occurs without implantation, consequently sterility practically always implies absence of fertilization. What subsequently happens to the fertilized and implanted ovum is of no moment so far as sterility is concerned. Even though a woman never bear a live child, but have repeated abortions, she cannot be considered sterile. Any other use of the word than that we have suggested breaks away from the correct philological meaning which implies direct negation both in its bacteriological² and gynaecological senses.

For this reason we should not here consider the question of abortion, even if it were pertinent to the present work. Moreover, we shall only deal with the question of sterility in woman, although we must briefly call attention to the frequency of male sterility.

According to the statistics of Gross, quoted by Matthews Duncan,³ the male is at fault in about 16.6 per cent of all sterile marriages, but no statement is made as to whether abortions are included by him under the heading of sterility. If so, one would be tempted to ask whether abortions which result from paternal syphilis are placed to the discredit of the father or the mother. We shall probably not be far wrong if we consider that male sterility exists in about one in every seven cases, that is in about 14.3 per cent of marriages which are sterile as we have defined the term.

¹ J. Matthews Duncan, *Sterility in Woman*, 1884, p. 1.

² Antisepsis has led to a misuse of the bacteriological sense as applied to the result of 'sterilization.'

³ J. Matthews Duncan, *loc. cit.* p. 2.

There is a further question which requires mention, but which, for obvious reasons, cannot be taken into statistical or gynaecological account. We refer to the prevention of conception by artificial means. This growing habit is an economic proposition, and only concerns us as gynaecologists when the health of the mother suffers directly from the practice. This aspect has already been briefly discussed.

True sterility in Woman may be classified best for descriptive purposes according to the causes, which may be local or general. Incidentally, we shall indicate whether the condition be temporary (curable) or permanent. It will be observed that in many cases this depends on the extent and severity of the lesion.

A. Local Anomalies.—Local disorders may act in several ways: complete coitus may be impossible; discharges may kill the spermatozoa, or the condition may be such that though the semen is properly placed and there is nothing to kill the spermatozoa, yet owing to some anomaly the spermatozoa cannot reach and fertilize the ovum.

I. Congenital Lesions.—(a) *The entire absence of any essential part of the genitalia* must necessarily lead to permanent sterility. Absence of the genital glands is very rare indeed, whereas absence of the uterus and the whole or upper part of the vagina is occasionally seen.

(b) *Gross anomalies* of the genital organs, such as undescended ovaries, congenital atresia of the cervix, and rudimentary development of the uterus and tubes all lead to permanent sterility. On the other hand, some of the minor congenital malformations, which if left alone would lead to permanent sterility owing to a mechanical obstruction to coitus or fertilization, are quite curable by simple surgical procedures.

(c) *Impenetrable hymen from undue toughness or atresia* can be dealt with by excision of this structure. The operation is so simple that a description of it is unnecessary.

(d) *Imperforation of the lower end of the vagina*, which is associated with haematocolpos, should likewise be treated by excision or incision of the obstructing membrane.

(e) *Partial Stenosis of the cervix* requires a little longer description. This error of development is of common occurrence and is usually described as a 'pin-hole os.' The condition is generally associated with under-development of the cervix (conical cervix) (Fig. 184), and sometimes, also, of the body of the uterus. Apart from the fact that dysmenorrhoea is common, sterility almost invariably results from the mechanical impediment to the entrance of the spermatozoa to the uterine cavity. That this is the real reason of the sterility is proved by the fact that operation—if the rest of the uterus be well developed—so frequently leads to a cure. Numerous operations

have been devised to remedy this condition. Simple dilatation may be successful,

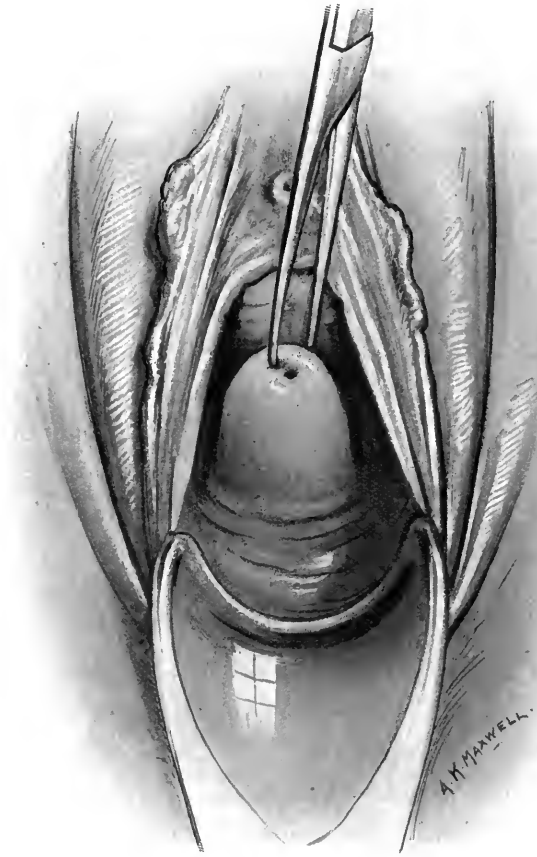


FIG. 184.—'Pin-hole' os and conical cervix.

but the result produced is not so permanent as some of the other operations.

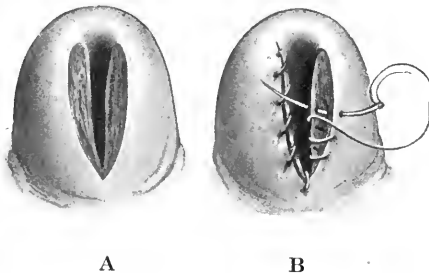


FIG. 185.—Posterior cervical section for 'pin-hole' os uteri.

A, Posterior cervical section; B, suture of the raw surfaces.

Dilatation and Incision of the Cervix.—

Various procedures have been adopted in regard to the incision of the cervix after preliminary dilatation. The simplest is the following: The posterior lip of the cervix is divided with scissors (Fig. 185, A). The cut edges are then tightly sewn over with chromic catgut to prevent reunion or eversion (Fig. 185, B).

A less simple but excellent procedure is that, first employed by Dudley, in which the rim of the external os is preserved.

This operation is performed in the following manner. Posterior section of the vaginal cervix is first effected as in the previous method. Next, a wedge-shaped piece is excised transversely from each cut surface (Fig. 186, A), and sutures are placed as shown in Fig. 186, B. The final result is shown in Fig. 186, C.

Pozzi's operation, which is now frequently performed, is carried out in the

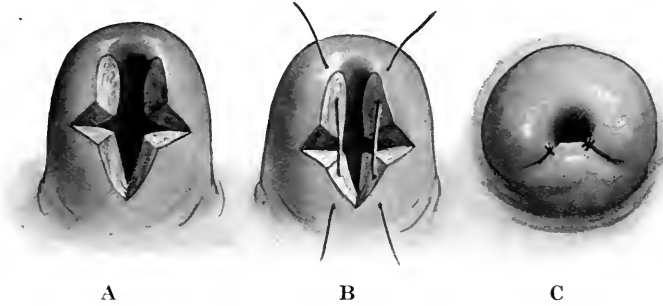


FIG. 186.—Dudley's operation for 'pin-hole' os uteri.

A, The incisions; B, suture of incisions; C, operation completed.

following manner. The cervix is split laterally on both sides for half an inch (Fig. 187, A). Next, a groove is cut on each of the four raw segments thus exposed (Fig. 187, B), to enable the operator to sew the vaginal surface of the cervix to the mucosa of the canal on each side, on the anterior and posterior lips respectively (Fig. 187, C). The final result shows a widely gaping external os uteri.

There is no doubt that this operation (Pozzi's) has proved beneficial in the relief both of dysmenorrhoea and of sterility. But there is one great disadvantage which we have occasionally observed in our own cases: the cervical mucosa tends to become everted, and eventually the appearance produced may resemble that of a cervix which has been lacerated during parturition some time previously; and there may be the excessive mucous discharge so often associated with that condition. This operation, indeed, has, in our opinion, no special advantage over posterior section of the vaginal cervix.

We are inclined to think that most of these procedures owe much of their success to the preparatory dilatation of the internal os, which is usually very tightly contracted in these cases. We have ourselves, in fact, occasionally divided the circular fibres with a probe-pointed bistoury passed along the slightly dilated canal, and then have passed larger dilators to stretch further the incised sphincter.

We think that dilatation, a slight division of the circular fibres surrounding the internal os uteri in an anterior direction, together with posterior division of the cervical cervix or Dudley's operation, form the best means of dealing with sterility due to stenosis of the cervix.

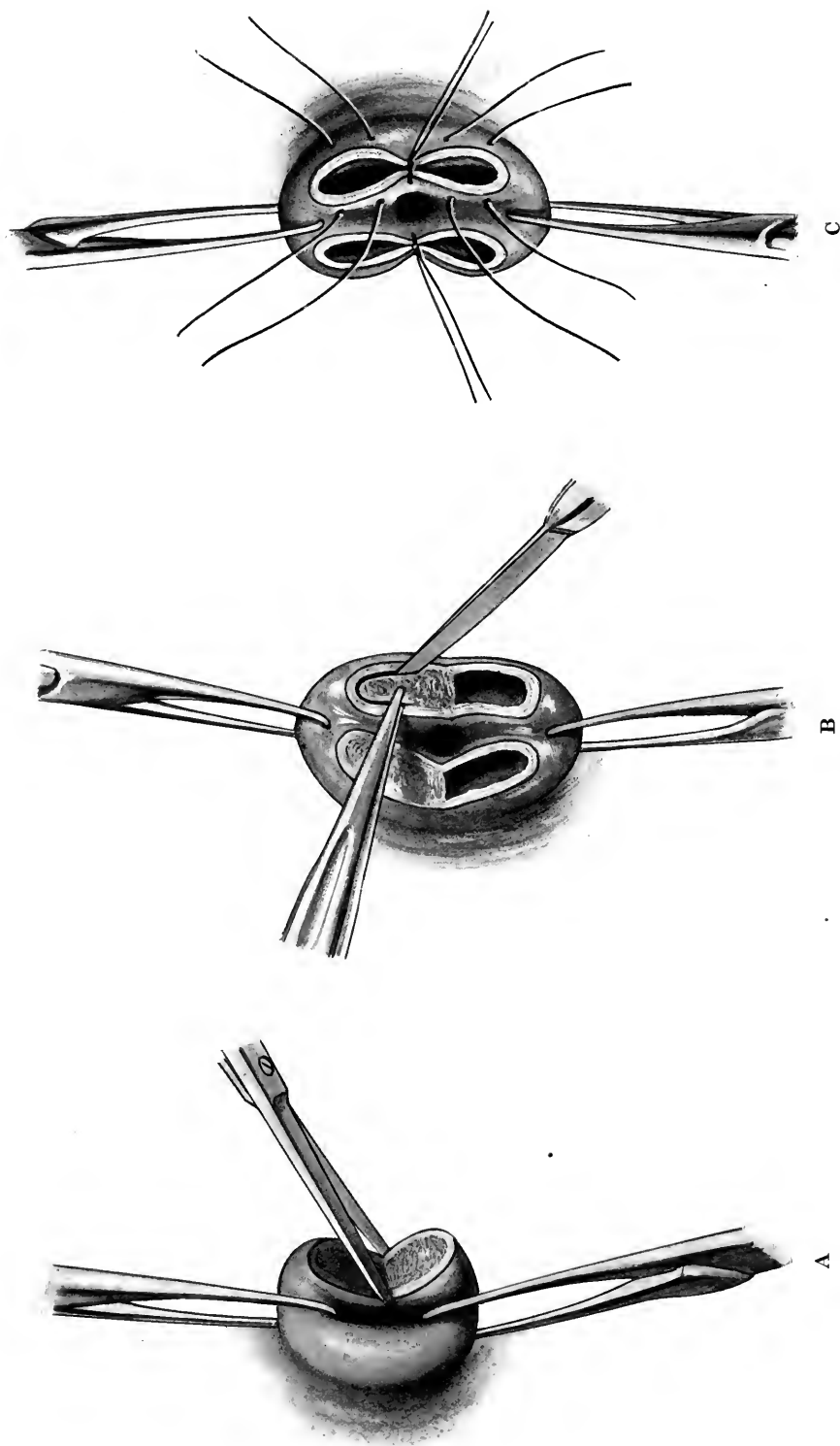


FIG. 187.—Pozzi's operation for 'pin-hole' of uteri.
 A, Lateral section of the cervix (this is carried out on both sides); B, excision of central portions of the raw surfaces;
 C, suture of the vaginal to the cervical mucosa.

(f) *Hypertrophy of the cervix* is not a very common condition, but when present may prevent fertilization. The treatment consists in amputating the vaginal cervix, and this may lead to a complete cure.

(g) *Partial Stenosis of the Fallopian Tubes*.—This anomaly is not infrequently seen in association with an imperfectly developed uterus. The stenosis may be complete, and in such circumstances the condition is incurable. But when the stenosis is not absolute, improvement may be effected and fertilization follow. The Fallopian tubes in these circumstances are usually small and somewhat tortuous near the uterine end; and this tortuosity may prevent the passage of a probe.

The best method of treatment in these circumstances is pneumatically to dilate the tube through the abdominal ostium, and not to risk damaging the lining membrane with a probe. The ampulla dilates readily, but the rest of the tube only slowly.

Pneumatic dilatation of the Fallopian tubes is carried out in the following manner. After laparotomy and an inspection of the tubes, the operator gently raises the ampullary portion of each tube in turn and holds it between the forefinger, thumb and middle finger of the left hand. The slightly curved nozzle, complete except for the needle, of a Gray's syringe,¹ with the piston drawn out and held in the right hand, is then pressed gently into the abdominal ostium, and air is slowly expelled from the syringe into the tube (Fig. 188).

Unless there be absolute stenosis, it should be possible to dilate the tube

¹ Designed for the injection of local anaesthetics, and made by Messrs. Down Bros., London.

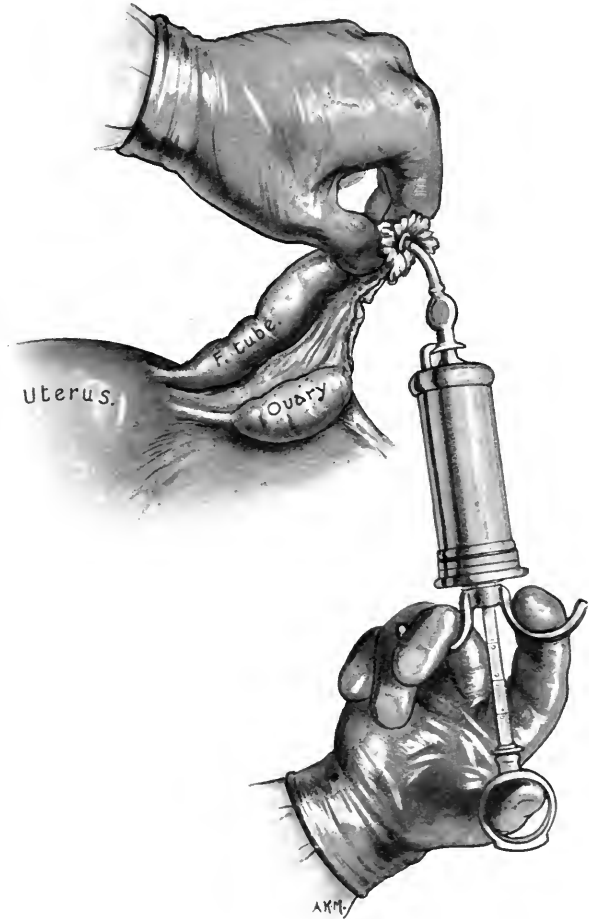


FIG. 188.—Method of treating partial stenosis of the tube by pneumatic dilatation.

throughout its entire length. If it were found that great force would be necessary to overcome an obstruction, the operator should not persist in further attempts lest he do irreparable damage to the patent portion of the tube.

(h) *Displacements* are not a common cause of temporary sterility, but may quite evidently be so. Retroversions may so tilt the cervix forwards that the spermatozoa have difficulty in reaching the external os uteri. That pregnancy does occur in these circumstances is well known, but this is not nearly so likely to happen as with retroflexion with the cervix in the normal position. Prolapse when complete may prevent normal coitus, and, consequently, conception. Chronic inversion of the uterus would, also, prove an almost insuperable barrier to fertilization and to normal implantation, for the uterine cavity no longer exists.

(i) *Traumata*.—Injuries may lead to temporary sterility by rendering the vagina inhospitable to the spermatozoa: thus, laceration of the cervix may be followed by eversion of the mucosa and the production of a profuse glairy discharge which may prevent the spermatozoa gaining access to the uterine cavity. So, also, urinary and rectal fistula connected with the uterus or vagina may lead to sterility owing to contamination of the semen with the discharge. Operative procedures, too, must be mentioned under the heading of traumata. These may produce permanent sterility, as is quite obvious when the removal of both ovaries, the tubes or the uterus is effected.

Likewise atmokausis and cauterization of the endometrium, methods which happily have passed out of use, have been known so to damage the uterus that its functions have been permanently destroyed.

(j) *Exposure to X-rays*.—If by design or accident the ovaries be exposed to the action of the X-rays through the abdominal wall, absolute sterility may ensue, owing to the destruction of the ova.

(k) *Infections*.—With infection of the genital tract of a mild character, especially if the causal agent be other than the gonococcus, temporary sterility may occur.

When the infection is acute the endometrium and lining membrane of the tubes may be so altered as to render impossible the transit of the ovum and spermatozoa; or, if fertilized, the implantation of the ovum. Should the acute infection subside without doing permanent injury to the lining membranes, the patient may subsequently become capable of impregnation and conception. This applies especially to streptococcal and staphylococcal infections.

Moreover, if the infection be such as to seal the abdominal ostia of the tubes, without seriously damaging the lining membrane, the patient may be rendered fertile by the performance of the operation known as salpingostomy, whereby a

large new orifice is made in the ampulla of the closed tube (Fig. 189). This applies, also, to occlusion of the tubes from pelvic infection due to appendicitis. In such circumstances the lining membrane of the tubes is usually unaffected.

When, however, the endometrium and lining membrane of the tubes are seriously affected sterility is absolute. Especially is this so in connexion with gonococcal and tuberculous infections of the Fallopian tubes, for in these diseases the lining

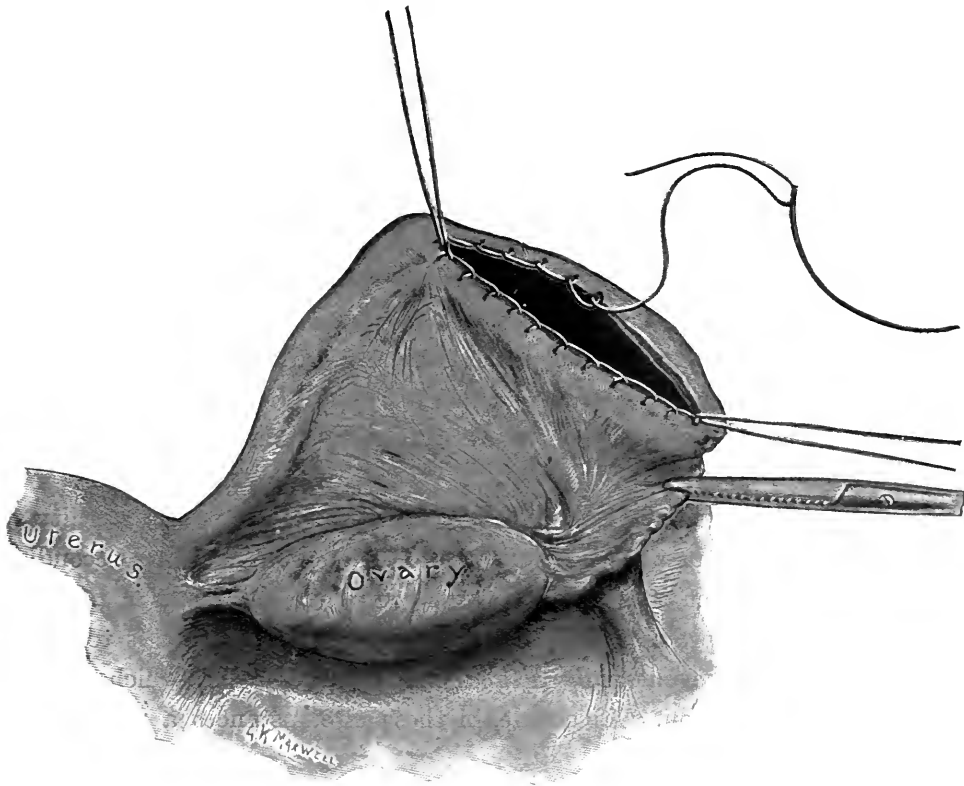


FIG. 189.—Method of performing salpingostomy.
(From article by the author in Burghard's *System of Operative Surgery*.)

membrane may be, and generally is, converted into granulation tissue with the formation of pyosalpinges.

(l) *New Growths*.—On the vulva and in the vagina new growths may prevent coitus. When growing from the vagina or cervix the discharge to which they give rise may destroy the spermatozoa, even if the growth itself, by blocking the vagina, be not a barrier to fertilization. If the neoplasm can be entirely excised the obstruction to coitus and conception is removed; if it be malignant the question of sterility is of no moment.

New growths of the uterus cause sterility chiefly by preventing the implantation of the ovum; that is to say, either the endometrium is not normal or excessive menorrhagia, epimenorrhagia and even metrostaxis may militate against the existence of a suitable nidus for the ovum.

In some cases of innocent fibromyomatous growths the disease may be so extensive as to lead to absolute sterility, either from distortion of or haemorrhage into the Fallopian tubes, or because the removal of the growth or growths cannot be effected without removal of the whole or part of the uterus.

Carcinoma of the body of the uterus would probably always cause absolute sterility, as would the means adopted in the cure of the disease (hysterectomy); but, of course, women with this disease are usually past the reproductive period of life. With cancer of the cervix in an early stage there is often no interference with the fertility of the patient, if circumstances be otherwise favourable to conception. When the disease is advanced, sterility though absolute is of no moment.

Malignant tumours of the Fallopian tubes and ovaries generally arise after the menopause; but when they occur at an earlier period the patient may be sterile.

Innocent growths of the ovary sometimes cause absolute sterility; often, however, the Graafian follicles ripen and rupture, and the ovum is set free and may become fertilized.

B. General Disorders.—General disorders which cause temporary sterility act in two ways. Firstly, coitus may be prevented or be impossible; and secondly, the disease present may affect the functions of the genital organs.

(a) *Psychoses* only produce temporary sterility indirectly; that is to say, complete coitus may be prevented by dyspareunia or vaginismus, which may result from nervous apprehension. As a rule, in these circumstances a natural cure is effected in the course of time.

It is probable that aversion from the male partner, such as may exist in a case of rape or even in legalized circumstances, has no influence on the fertility of the woman beyond lessening the likelihood of genital turgescence and follicular dehiscence, which are more likely to occur under propitious conditions.

(b) *Malnutrition*.—Marshall¹ has shown that nutrition and environment affect in a marked degree fertility in animals. Many other investigators had previously made similar observations. We know, likewise, that girls in factories, who are badly fed and live in unhygienic surroundings, may be late in arriving at maturity, and consequently relatively sterile.

(c) *Selective Sterility*.—We prefer to use this term instead of the usual and classical

¹ F. H. A. Marshall, *Science Progress*, 1908, No. 7, p. 369.

one, 'incompatibility,' which is not used in connexion with other physiological processes. Generally speaking, we may refer to 'selective sterility' when two individuals of opposite sexes are unable to procreate, although each may be potent in this respect with another partner.

The actual cause of this selective sterility is unknown, but to us it appears probable that some of the biological processes of natural selection, about which we know so little, lie behind this so-called incompatibility, and it is for this reason we have given this variety of sterility a fresh name, and one which at least contains an explanation, however wide it may be in its application.

(d) *Debilitating diseases* which disturb greatly the metabolism of the body may lead to sterility. As a rule the genital functions in regard to menstruation are affected, and scanty menstruation or secondary amenorrhoea of a temporary or permanent nature is produced. Sterility, in fact, almost invariably co-exists with such disturbances. Anaemia, associated with reduction of the haemoglobin content of the blood, fevers, and general ill-health through overwork, bad feeding or great physical exertion, may all produce temporary sterility.

Acute fevers sometimes lead to permanent sterility, and this is caused by the changes which may occur in the organs of internal secretion in these diseases.

(e) *Disturbances of the Endocritic Organs.*—The internal secretions may be said to affect fertility by their influence on the structural integrity and the functions of the genital organs. As we have seen, normally there is a correlated relationship between counterbalancing hormones which, so far as the functions of menstruation and conception are concerned, are linked up by the ovarian secretions.¹

Now, normally some of these secretions, such as those of the thyroid and pituitary (? anterior lobe)—are stimulative or augmentative; while others, such as that of the suprarenal cortex, are antagonistic to the genital functions in woman. We have discussed this already, but may point out again here that these tendencies have been demonstrated chiefly by pathological observation and physiological experiment; and that apparent paradoxes may arise: thus, while a normal output of pituitary secretion is necessary for the normal condition of the genital functions, yet an excessive anterior lobe output produces masculinity and, therefore, feminine genital insufficiency; furthermore, marked anterior lobe insufficiency also produces genital inactivity directly (p. 328 *et seq.*). It is obvious, therefore, that a normal endocritic balance is required to conduce to perfect genital activity, and that those changes in the organs of internal secretion which produce either masculinity or a deficient supply of a necessary hormone may induce sterility.

¹ W. Blair Bell, Arris and Gale Lectures, R.C.S., *Lancet*, 1913, vol. i. pp. 809, 937.

To recapitulate the position which has already been discussed, it may be said that thyroid, pituitary and ovarian insufficiencies produce sterility directly; and that pituitary and suprarenal hyperplasias and neoplasias by giving rise to masculine characteristics indirectly render fertility impossible.

It may be pointed out that obesity, so frequently mentioned as a cause of sterility,¹ is probably often an epiphenomenon of the same disease of the endocritic system; that is to say, insufficiency of ovarian, thyroid or pituitary secretion may cause both obesity and sterility. At the same time it has been shown² that fatness resulting from overfeeding in animals may cause sterility directly.

When there is any definite derangement in the endocritic system the degree of sterility—that is to say, whether it be temporary or permanent—depends on the curability or otherwise of the disease in question.

(f) *Physiological Causes*.—We may consider such conditions as are normal to any given individual, whether responsible for temporary or permanent sterility, to be causes of physiological sterility.

Thus the age of the patient has an important bearing on the question of fertility. Matthews Duncan³ gives a very interesting table which shows the differences in fertility during the first two years after marriage in a large number of cases of women married at the ages of 16, 17, 18 and 19 years. The percentages of those who became mothers within two years of marriage in the different groups were 12·9, 30·0, 46·4 and 57·8 respectively.

Moreover, after the age of 35 years the fertility of newly married women decreases in a remarkable fashion; for the same author shows that, taking the five-year inclusive periods of the ages 30-34, 35-39, 40-44 and 45-49, the respective percentages of those who bore children in the first two years after marriage were, in the different groups, 62·9, 40·9, 15·4 and 4·3 respectively.

Between puberty and the menopause, then, the degree of fertility varies, but sterility is never absolute so far as age between these periods alone is concerned. After the menopause child-bearing usually ceases, but, as we have mentioned already, conception has taken place many years after the cessation of menstruation (p. 381).

Further, there is no doubt that many women are only fertile at certain periods of the menstrual cycle, and this probably depends on the time of ovulation. It is for this reason that sometimes married couples—especially Roman Catholics who thus evade the letter of the law—prevent conception by limiting sexual intercourse to some special period, usually the middle of the menstrual cycle.

¹ J. Matthews Duncan, *Sterility in Woman*, 1884, p. 117.

² F. H. A. Marshall and W. R. Peel, *Journ. Agricult. Sci.*, 1910, vol. iii. pt. iv. p. 383.

³ J. Matthews Duncan, *loc. cit.* pp. 56, 57.

Throughout pregnancy, except in the very rare cases of superfoetation which may occur in the normal and in the double uterus, women are sterile. During lactation menstruation is, as a rule, in abeyance, and probably ovulation does not usually occur in these circumstances. Women, therefore, often believe that it is impossible for them to conceive at this time; consequently in the poorer classes they not infrequently nurse their children for protracted periods to avoid, if possible, gestation. There is no doubt that conception may be avoided in this way; but it is by no means always so. We have known a woman who stated definitely that for over twenty years she never menstruated at all owing to the rapidity with which pregnancy followed pregnancy, and to the fact that conception invariably took place while lactation was in progress.

* * * * *

How complicated are the derangements of function in respect of sex characterization, menstrual disorders, and anomalies of fertilization and conception will have been gathered from the foregoing remarks. The recent discoveries concerning the influence of *all* the internal secretions on the functions of woman, rather than that of the gonads alone, as previously thought, have widened the horizon immeasurably, and have at last brought gynaecology and obstetrics into the domain of biochemistry. So, too, modern discoveries in gynaecological physiology and in connexion with the morphology and histological pathology of the female genitalia have placed our knowledge on sure foundations. Already improvements in our medical and surgical treatment are evident; while the future holds for those who work on scientific lines hope of still further and greater discoveries and improvements within a short time. But in these extending vistas of biological endeavour and achievement, which are opening up before us, we must not lose sight of the human elements in our subject. Woman both in her mentality and physical functions is normally variable, often paradoxical. And in the disorders of her mind and physiological activities she is correspondingly elusive and difficult of comprehension. Only by recognizing the close association between the psychical and physical can we hope in many difficult circumstances to reach a successful issue.

ECTOPIC GESTATION

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Definition.—When a fertilized ovum or oö sperm lodges and develops in any part of the genital tract other than the cavity of the uterus, it is said to form an extra-uterine or ectopic gestation ; and when this occurs in the ovary or the Fallopian tube it is termed an ovarian or tubal pregnancy respectively. There are two other conditions which it is convenient to include under the term “ectopic pregnancy,” namely when an oö sperm develops in the undeveloped cornu of a bicornute uterus, and the very rare form of so-called ‘primary abdominal pregnancy.’ The question whether an oö sperm can acquire a primary attachment to and develop on the peritoneum is still unsettled, although some cases, apparently of this nature in the human subject, have been recorded.

Four varieties of tubal pregnancy are recognized, depending upon the portions of the tube in which the ovum is attached. They are termed respectively interstitial or tubo-uterine, isthmal, ampullary, and tubo-ovarian. Ectopic gestation may be divided into primary and secondary forms. The first class includes the various forms of tubal, ovarian, and ‘primary abdominal gestation’ ; and the second class intraligamentary gestation, which commences in the tube and develops subsequently between the layers of the broad ligament (forming either an anterior subperitoneal or a posterior subperitoneal pregnancy), and secondary abdominal gestation.

ETIOLOGY OF TUBAL PREGNANCY

In order to reach the uterine cavity the ovum must traverse the Fallopian tube. When a fertilized ovum is retained in the tube and continues to develop it gives rise to the condition known as tubal pregnancy. Our knowledge of the causes which lead to the retention of the fertilized ovum in the tube is very

imperfect, and in any attempt to render it more perfect it is necessary to determine in which part of the genital tract fertilization of the ovum usually occurs.

The difficulties of this investigation are increased by the fact that we know nothing of the development of the human ovum during the first twelve days, the earliest human ovum which has been described being the Teacher-Bryce¹ ovum, the age of which is estimated at 13 to 14 days. It was held formerly that fertilization occurs usually in the uterus, and this view had the support of Lawson Tait, Martin, Dührssen, and Bland-Sutton. More recent investigations, however, have thrown

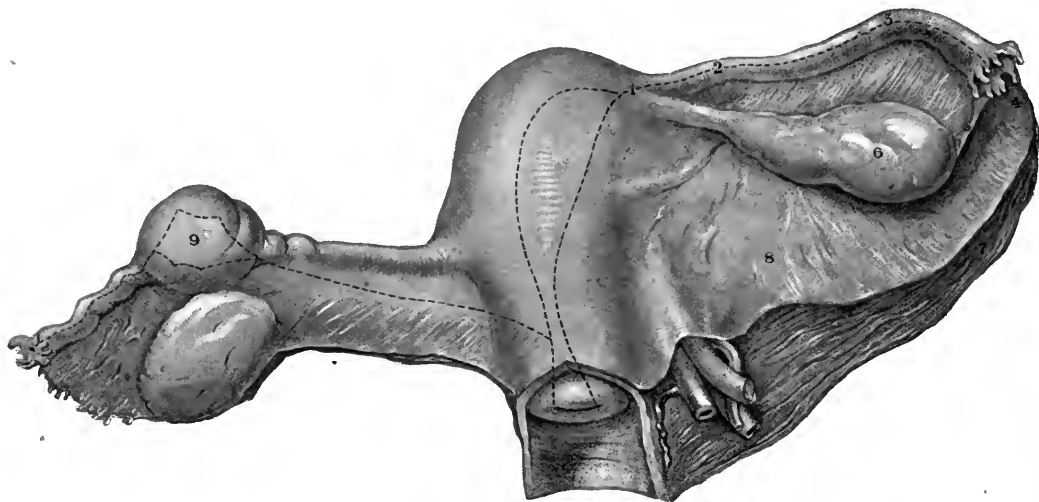


FIG. 190.—A composite drawing showing the possible sites of implantation of the ovum in an ectopic gestation.

- | | | | |
|---|--------------------|------------------|-----------------------|
| 1. Interstitial. | 3. Ampullary. | 5. Tubo-ovarian. | 7. Intraligamentary. |
| 2. Isthmal. | 4. Tubo-abdominal. | 6. Ovarian. | 8. Primary abdominal. |
| 9. In the undeveloped horn of a <i>uterus unicornis</i> . | | | |

some doubt upon this hypothesis, and it appears likely that the meeting of the spermatozoon and the ovum normally takes place in the tube, and probably in its ampullary portion. Lawson Tait taught that the current produced by the action of the cilia of the tube was downwards, and that of the cilia of the uterus upwards, and that they antagonized one another in the upper part of the uterus, but this has been disproved by the observations of Hofmeier and Mandl, who have shown that the current both in the uterus and the tube is towards the cervical canal. If we believe that normally fertilization takes place in the uterus, then every tubal pregnancy is due to ectopic fertilization. Conditions promoting this, as Wyder points out, may be abnormal patulence of the uterine opening of the tube, or absence of

¹ T. H. Bryce and J. H. Teacher, *Early Development and Imbedding of the Human Ovum*, 1908.

the action of the tubal cilia. Either of these two conditions would favour the entrance of spermatozoa into the tube, and the observations of Birsch-Hirschfeld and Dührssen¹ have shown that spermatozoa may be found in the Fallopian tube, and it is known that in some animals they retain their activity in this position for long periods of time. If we admit that fertilization generally takes place in the tubes, then every pregnancy commences as an extra-uterine gestation, and the conditions which tend to retain the ovum in the tube must be such as would prevent its entrance after fertilization into the uterine cavity. The causes may be considered under three heads, viz. :

(1) Anomalies of the ovum or of the ovary.

(2) Mechanical interference with or failure of the forces which ordinarily lead to the passage of the ovum into the uterus.

(3) Developmental or other abnormal conditions of the tube itself.

1. *Anomalies of the Ovum or of the Ovary*.—Bland-Sutton from his observations believes that a tubal pregnancy is the result of active rather than of obstructive causes. Very little change occurs in the size of the fertilized ovum up to the time of the formation of the blastocyst, and it is improbable that its arrest in the tube can be due merely to its size. If fertilization takes place normally in the tube, arrest of the ovum after fertilization may occur not infrequently in this position, but in the great majority of such cases the ovum dies, and only in a small percentage does a tubal gestation result. Our knowledge of the anomalies of the fertilized ovum is very scanty. If the zona radiata, the disappearance of which in the mouse seems to take place at the eight-cell stage, and even later than this in the bat, disappears prematurely, this may lead to the embedding of the ovum in the tube, and Kossmann² has suggested that in cases of chronic oöphoritis the cells of the corona radiata may be retained in the ruptured Graafian follicle, instead of coming away with the ovum, and that this may favour its early embedding. We know nothing, however, of the functions of the cells of the corona radiata, but Robinson³ has suggested that the zona radiata may serve to prevent the premature embedding of the early ovum. Ballantyne also has suggested that, if from any cause the ovum is retained in the tube until the trophoblast is fully formed, or if the ectoblast is developed into trophoblast prematurely, lodgment may be effected on the tubal mucosa. Opitz⁴ has described spontaneous movements of the fertilized ovum, and thinks that the loss

¹ A. Dührssen, "Lebendige Spermatozoen in der Tube," *Zentralbl. f. Gynäk.*, 1893, No. 25, 593.

² Kossmann, *Zeitschr. f. Geb. u. Gynäk.*, 1893, xxvii. 212.

³ Robinson, "On the Early Stages of Development of the Mammalian Ova, and on the Formation of the Placenta," *Hunterian Lectures, Journ. Anat. and Phys.*, 1904, xxxviii. 186.

⁴ Opitz, *Zeitschr. f. Geb. u. Gynäk.*, Stuttg., 1902-1903, xlviii. 538.

of this power of movement may result in the oöperm being arrested and developing in the tube.

Vautrin¹ has put forward the view that the implantation of the ovum in the tube is dependent upon some abnormality in the action of the secretion of the corpus luteum, or to some abnormality of the ovary itself, such as cystic disease with over-development of the lutein cells, and resulting excess of their internal secretion. According to this view the most important factor in the production of an ectopic gestation is not an abnormal condition of the tubes or uterus, but of the internal secretion of the ovary.

In a considerable number of cases (in 5 of 30 cases examined by Williams) the corpus luteum is found in the ovary opposite to the pregnant tube, showing that external migration has occurred, and that the fertilized ovum has traversed the pelvic cavity and entered the opposite tube. This condition was first described by Oldham,² in a case in which the corpus luteum was in the right ovary, the abdominal ostium of the corresponding tube was closed, and the left tube contained a ruptured tubal gestation in its isthmal portion. In cases of internal migration the ovum passes into the uterus and then into the opposite tube where it becomes embedded. In both cases it is obvious that the path it traverses may be lengthened, and it has been suggested by Sippel³ that the ovum therefore may have undergone a degree of development sufficient to cause it to become at once embedded in the tube when it reaches it, or to interfere with its farther passage into the uterus. External migration is particularly frequent in cases of pregnancy in the undeveloped horn of a uterus bicornis. If internal migration ever occurs in these cases, then we must admit that a communication between the rudimentary horn and the uterine cavity may become secondarily shut off, which is possible, but improbable. Internal migration is also the most likely explanation of such cases as those recorded by Morfit, Benzel,⁴ and Campbell,⁵ in which a tubal pregnancy has occurred in the stump of the tube left after a previous salpingectomy. It is of course quite possible that in many cases of external wandering or migration of the ovum a normal uterine pregnancy results. Russell Andrews⁶ has recorded a very remarkable case of simultaneous intra-uterine and extra-uterine pregnancy, in which a ruptured interstitial pregnancy was found at the right cornu of the uterus, and a very careful search failed to discover any trace of the right tube or ovary, so that internal wandering of the ovum must have occurred.

¹ Vautrin, "L'Inondation péritonéale dans l'avortement tubaire," *La Gynécologie*, 1911, Par. xv. 637.

² Oldham, *Guy's Hosp. Reports*, 2nd series, 1845, iii. 272.

³ A. Sippel, *Zentralbl. f. Gynäk.*, 1901, No. 12, 290.

⁴ F. Benzel, *Beiträge zur Geburtsh. u. Gynäk.*, 1912, xvii. 162.

⁵ J. L. Campbell, *Journ. Amer. Med. Assoc.*, 1910, liv. 874.

⁶ Russell Andrews, *Proc. Roy. Soc. Med.*, 1912, vi. Pt. 2, 52.

Although external migration seems difficult to explain, yet the frequency with which both tubes may be found low down in Douglas's pouch with their fimbriated extremities almost in contact, renders its occurrence easier to understand, and at the same time demonstrates that the lengthening of the path which the ovum has to travel on its way to the uterus may be comparatively unimportant.

The proof of the occurrence of internal wandering of the ovum requires certain evidence that the ostium of the gravid tube had been so completely occluded as to preclude any possibility of the ovum finding its way into it from the abdominal cavity. This is often difficult to prove with certainty.

2. *Mechanical Interference with, or some Failure of the Forces which ordinarily lead to, the Passage of the Ovum into the Uterus.*—Failure of the propelling forces may be classified under two heads, viz. changes in the musculature of the tubal wall interfering with its power of contraction, and disappearance of the ciliary currents in the tube as a result of changes in or shedding of the epithelium. It has been suggested that the ovum is too small a body to be influenced in any way by contractions of the tubal wall, but it is conceivable that anti-peristaltic action may hinder its passage towards the uterine cavity. There is, however, no proof that any such inverted action of the tubal muscle occurs. Any failure in the propelling forces must be considered then in the form of deficiency in the ciliary action due to changes in, or actual shedding of, the tubal mucosa as the result of chronic salpingitis. The occurrence of pregnancy in the Fallopian tube, after a long period of sterility in women who have borne children, has led to the view, supported by Lawson Tait and Tilt among others, that these patients have suffered from chronic salpingitis, and that the destruction of the tubal epithelium has hindered the passage of the ovum into the uterus. The observations, however, of Bland-Sutton, Werth, and Veit have shown that in a very large number of cases of tubal pregnancy there is no evidence of old salpingitis, and indeed a healthy Fallopian tube ¹ is probably just as likely to become the seat of a tubal gestation as one which has been inflamed.

J. W. Williams, in studying this question, was able to find cilia in all his cases, and Zedel ² in several recent specimens found the cilia in motion. It must be remembered that the absence of cilia in patches cannot be accepted as evidence that the normal ciliary current in the tube is wanting, nor can the presence of the cilia be taken as a proof that the tube is entirely healthy, as they may be present in tubes showing definite signs of old inflammation. As Bland-Sutton points out, salpingitis so severe as to result in destruction of the tubal epithelium causes profound changes in the

¹ Bland-Sutton, *Surgical Diseases of the Ovaries*, London, 1896, p. 245.

² J. Zedel, *Zeitschr. f. Geb. u. Gynäk.*, 1893, xxvi. 78.

tubes, and generally leads to occlusion of the abdominal ostium. Chronic salpingitis may account for the sterility and the subsequent tubal pregnancy in a small proportion of the cases, but it fails to account for the great majority of them. Inflammation of the tubes becomes even less satisfactory as an explanation of tubal pregnancy when we remember that in many cases the inflammation is the result rather than the cause.

Some writers have suggested that the frequency with which cases of gonorrhoeal salpingitis and ectopic gestation are met with in large towns may stand in the relation of cause and effect. Rabinovitz,¹ from an examination of 147 repeated tubal pregnancies, believes that gonorrhoeal salpingitis is the predominant cause of tubal pregnancy, and that the responsible lesion most likely is the destruction of the ciliated epithelium. He further believes that, in the majority of the cases, the ascending gonorrhoeal infection affects the tubes successively. It is therefore not unusual for the tube which is left *in situ* on account of its apparently normal condition, to undergo further pathological processes sufficient to furnish a predisposing factor for a recurrent tubal gestation. The thickening of the tubal mucosa which results from gonorrhoeal salpingitis may form a physical obstacle to the passage of the ovum into the uterus. It is often almost impossible to determine with certainty whether the inflammation is recent or of old standing, and a very complete examination of the tube is required to settle this point. Not infrequently in cases of tubal gestation the opposite tube is found to be the seat of hydrosalpinx, pyosalpinx, or haematosalpinx. Dührssen, in 24 of 35 cases, found disease of the tube, and considered that in most of the cases this was due to gonorrhoea, while in 12 of 14 cases Petersen found evidence of salpingitis. Engström and Fiedler agree with this view, but on the other hand Finsterer,² in a series of 133 cases all treated by operation, found serious changes in the adnexa in only 28 cases, and slight changes in 8 cases, and is not prepared to admit that antecedent inflammation of the adnexa plays the important part so generally attributed to it. If gonorrhoea were the most important factor, most of the women would have been sterile, as it is hardly likely that gonorrhoea would have been acquired after repeated child-bearing, and 97 of 120 women had previously had normal labours.

That a tubal gestation may occur, even in a tube the seat of acute inflammatory changes, is shown by the cases recorded by Hitschmann, Orthmann, Veit, Zweifel, Petersen, and Lockyer. In Hitschmann's³ case the tubal wall contained an abscess, and only a narrow band of muscle intervened between the pus and the chorionic villi.

¹ M. Rabinovitz, *Amer. Journ. Obstet.*, 1911, lxiv. 238.

² Finsterer, *Zeitschr. f. Heilkunde*, 1908, xxviii. Suppl. Hft., 205.

³ F. Hitschmann, *Zeitschr. f. Geb. u. Gynäk.*, Stuttgart, 1904, liii. 1.

In Lockyer's¹ case a tubal mole was present in the wall of a pyosalpinx, and he explained the case as one of pregnancy occurring in a tube the seat of chronic interstitial salpingitis, and that following the formation of the mole the tube had become converted into a pus-sac. The possibility of a pregnant tube becoming secondarily

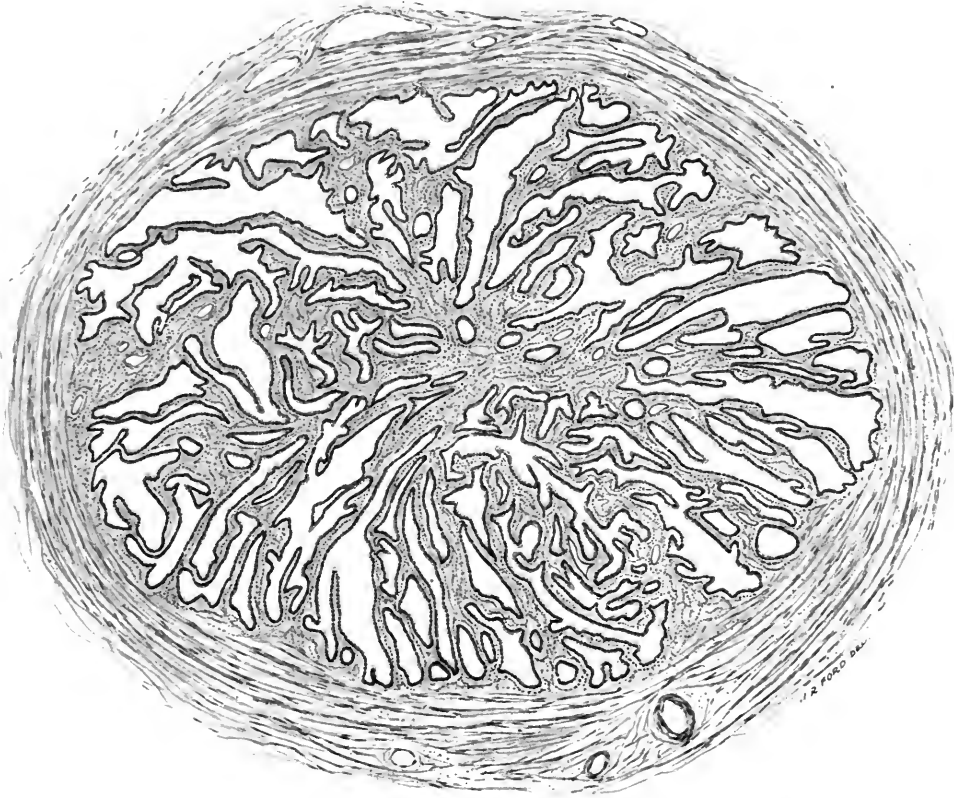


FIG. 191.—A section through the Fallopian tube on the uterine side of a tubal pregnancy, showing adhesions between neighbouring folds of the mucosa producing partial obliteration of the lumen.

inflamed cannot be denied, and probably in this way the infection of a tubal mole occurs in many cases.

For a very complete account of the inflammatory changes found in the wall of the pregnant tube we are indebted to Opitz,² who has drawn special attention to the frequency of false diverticula, formed by the adhesion of adjacent folds of the mucous membrane of the tube, leading in some places almost to the obliteration of the lumen (Fig. 191). These false diverticula usually run parallel to the direction of the tubal lumen and communicate with it, and the appearance of the tube closely resembles

¹ C. Lockyer, *Proc. Roy. Soc. Med.*, 1908, i. Pt. 2, 248.

² Werth, quoted by von Winckel, *Handbuch der Geburtsh.*, 1904, ii. Pt. 2, 864.

the condition described as "follicular salpingitis." Similar conditions can be found in the non-pregnant tube, and it is obvious that if a fertilized ovum finds its way into one of these diverticula it may develop there, and so give rise to a tubal gestation. Opitz also has described down-growths of the epithelium into the stroma of the tubal folds, and even into the muscle-tissue. The fact that such changes may be found in tubes apparently healthy to the naked eye, shows that the assumption that a tubal pregnancy has occurred in a healthy tube must be made with great caution, since to an ordinary examination no external evidence of any inflammatory changes may be present.

Prusmann found, in 20 of 28 pregnant tubes examined, adhesions between the folds of the mucosa in the portion of the tube intervening between the implantation site of the ovum and the uterus. As in many cases no traces remain to an ordinary clinical examination of any previous inflammation, a history of such an attack is always of great value. The cases relatively frequent in which a second tubal pregnancy occurs on the opposite side may be regarded either as evidence of some condition affecting both tubes, or as evidence of some abnormality of the fertilized ova in the woman concerned.

There is another curious mode of origin which appears to occur in women who are not in any degree sterile, namely the possible interference of one ovum with another on their way to the uterus. This may take place either in cases of multiple pregnancy in the same tube, or in cases of pregnancy occurring simultaneously in the tube and the uterus. In the latter case it is quite possible that the onset of the intra-uterine pregnancy is associated with hypertrophic changes in the mucosa of the tube, which may form an obstacle to the progress of the second ovum to the uterus, and this may well account for the relative frequency of such cases.

Another variety of an apparent twin tubal pregnancy is that in which an old tubal pregnancy damages the tube, and so leads to the retention in it of a second ovum, although in such a case it is more probable that the condition of the tube preceded, and did not follow, the first pregnancy. The influence of old pelvic peritonitis in producing adhesions occluding the lumen of the tube, or interfering with its normal muscular contractions, is a possible cause which must not be lost sight of.

These conditions are, however, only met with in a small percentage of the cases, and are usually associated with changes in the mucous membrane of the tubes. Emotional disturbances at the time of coitus, or physical trauma have been suggested by Freund and Seeligmann, but fertilization and coitus do not usually correspond, and physical trauma, as an explanation, is impossible to accept. An actual lengthening of the path traversed by the fertilized ovum may be caused by the presence of

intraligamentary tumours of the ovary, or fibromyomata of the uterus with the tubes stretched over them, but although such conditions are not infrequently met with in association with tubal pregnancy, this must not be taken to mean that there is of necessity any causal relationship.

The occurrence of a tubal gestation in an accessory tube would appear to be a probable accident, and it is surprising to find so few cases on record.¹ The best known is that described by Henrotin and Herzog² in which a small blind accessory tube on the right side was filled with blood-clot containing normal and partly necrotic chorionic villi. Diverticula of the tube also have been regarded as a possible site for the development of an ectopic pregnancy. They occur not infrequently as offshoots from the lumen of the tube, which may extend some little distance parallel to it and end blindly. The fuller knowledge we now have of the manner in which the ovum embeds itself in the mucosa of the uterus and of the tube, renders it probable that most of the cases in which the ovum is thought to be situated in a diverticulum are in reality examples of this embedding process. It is, however, a possible, and indeed probable, explanation of some cases. It is possible also that the presence of myomata in the uterus may interfere with the lumen of the tube, and so cause the retention of an ovum in this part of the genital tract. F. E. Taylor³ has collected 16 cases of this kind, but the frequency of fibromyomata of the uterus is such that the presence of this condition in association with a tubal gestation may be merely a coincidence.

The presence of polypi in the tube has been invoked by a number of writers as a possible cause, and cases of this kind have been recorded by Leopold, Wyder, Dührssen, and others.⁴ The infrequent occurrence of such an outgrowth in the large number of tubes which have been examined of late years renders this probably a very unusual cause, and it is always likely that the polypoid hypertrophy of the mucous membrane has followed, and not preceded, the tubal gestation.

3. *Developmental or other abnormal Conditions of the Tubes.*—It is a matter of common observation that in some cases of tubal pregnancy, particularly in those occurring in women who have previously borne children *in utero*, the walls of the tubes are unusually thin, and it has been suggested that this condition may be due to excessive involution of the tubes in the puerperal period (Dührssen, Taylor).⁵ Such a state of the tubes may also be due to congenital hypoplasia, or to a persistence of the

¹ M. Walthard, *Zeitschr. f. Geb. u. Gyn.*, 1911, lxi. 553.

² Henrotin and Herzog, *Rev. de Gyn. et de Chir. Abd.*, 1898, ii. 633.

³ F. E. Taylor, *Journ. Obst. and Gyn. Brit. Emp.*, 1906, ix. 412.

⁴ W. Vassmer, *Monatsschr. f. Geb. u. Gyn.*, 1903, xvii. 881.

⁵ J. W. Taylor, *Extra-Uterine Pregnancy*, 1899, p. 24.

infantile condition, and, as Taylor has pointed out, this mal-development is often associated with early rupture. When a convoluted tube is met with in an adult it does not, however, always signify hypoplasia, for the convolutions may be the result of inflammatory processes (Fig. 192). Fusion of the folds of mucous membrane



FIG. 192.—An early unruptured tubal pregnancy; salpingitis. (U.C.H. Med. Sch. Museum, No. 689.)

does not occur in tubes the seat of true hypoplasia, and a tubal gestation occurring in such a tube must be referred rather to the general mal-development than to the presence of the convolutions.¹

Webster maintains that for tubal pregnancy to occur a decidual reaction must take place in the tube, and explains their comparative rarity by the fact that this reaction is usually lacking. Normally it takes place in the mucosa

of the uterus, and its occasional occurrence in other parts of the genital tract derived from the ducts of Müller, namely the Fallopian tubes, is to be regarded as a reversion in these tissues to an earlier mammalian type, either in structure or in reaction-tendency. Webster holds very strongly that an ectopic gestation never begins on any other than Müllerian tissues. The fact that gestation may occur in the ovary, he does not consider invalidates this view, and he explains this by the fact that Müllerian tissue derived from the ovarian fimbria may be found extending into the ovary. As further evidence he calls attention to the observations of Schmorl, and of himself in regard to the occasional occurrence of small localized areas of decidua-like cells in the ovary in cases of uterine pregnancy. He believes that these areas represent detached portions of Müllerian tissue, and that a special genetic action in them may occasionally determine the fertilization and embedding of an ovum in the ovary. In a similar manner he believes that the development of small areas of decidua in the peritoneum, in the broad ligaments, and in the connective tissue in the muscle-wall of the uterus, is due to the presence of detached portions of Müllerian tissue. This atavistic theory has received support from Moericke, Patellani, Schmidt, and Mandl, but, as Whitridge Williams points out, it is based rather upon theoretical considerations than upon anatomical observations. Huffman² has lately put forward a theory that the occurrence of a tubal pregnancy is due to the persistence of embryological rests, constituting what he terms an anomalous embedding area, to which the ovum can acquire an attachment.

¹ O. Höhne, *Zeitschr. f. Geb. u. Gynäk.*, 1908, lxiii. 106.

² O. V. Huffman, *Surg. Gyn. and Obstetrics*, 1913, xvi. 548.

Some of the most remarkable cases are those in which the pregnancy has occurred in the stump of a tube which has been removed, or in which a supra-vaginal amputation of the uterus has been performed, and the spermatozoa have found their way through the canal of the cervix into the tube and fertilized an ovum in this position. In the case recorded by Keller the whole uterus had been removed, and no doubt the stump of the tube had healed into the angle of the vaginal scar. Benzel¹ has recorded a case of the first kind, in which the pregnancy occurred in the stump of the tube which had been removed for an ectopic gestation. Wesenberg² and Glitsch have both recorded cases in which a tubal pregnancy occurred in a tube upon which the operation of salpingostomy had been performed at the time the opposite tube was removed.

Attempts to produce tubal pregnancy by experiments on animals have uniformly failed. Tainturier attempted to interpose a mechanical hindrance to the passage of the fertilized ovum into the uterus both by ligating the tube, and by damaging the tubal mucosa. Mandl and Schmit carried out a similar series of experiments without any success. When the uterine ends of the tubes were ligatured, dead ova could be found in the tubes beyond the ligatures, but no sign of any tubal pregnancy.

Bland-Sutton has shown that primary ectopic gestation in the lower animals is practically unknown, only one doubtful case occurring in a baboon having been recorded by Waldeyer. So-called 'secondary abdominal gestations,' on the other hand, are comparatively common, and are due to the rupture of the uterus with the escape of the foetuses into the abdominal cavity. Kamann³ has recorded a case of this kind in the dog, and has collected some forty other cases. Blair Bell⁴ has recorded a case of what he believes to be 'primary abdominal pregnancy' in a rabbit, in which the most careful examination of the uterine horns and Fallopian tubes failed to show any sign of rupture. The tumour found in the abdomen was adherent to the gastro-colic omentum by a narrow pedicle, and contained the skeletons of four full-time foetuses.

A tubal pregnancy may obviously be due to more than one factor, and its exact causation is usually impossible to determine. The most probable predisposing cause would seem to be one of the mechanical conditions described as interfering with the passage of the ovum along the tube, but it must be remembered that both true and false diverticula occur not very infrequently, and that chronic salpingitis or follicular

¹ F. Benzel, *Beiträge z. Geburtsh. u. Gynäk.*, 1912, xvii. Pt. 2, 162.

² W. Wesenberg, *Zentralbl. f. Gynäk.*, 1911, No. 51, 1716.

³ Kamann, *Monatsschr. f. Geb. u. Gyn.*, 1903, xvii. 588.

⁴ Blair Bell, *Proc. Roy. Soc. Med.*, 1911, iv. Pt. 2, 228.

salpingitis is certainly not present in many cases of tubal gestation. When it is present, however, it forms the most likely explanation of the accident, for in all cases an ectopic gestation may be regarded as of the nature of an accident.

A tubal pregnancy may occur as the first pregnancy in a woman who has been married eight, ten, or twenty years. A patient operated upon by Bland-Sutton for rupture of a gravid tube had been married twice, and her married life had extended over seventeen years before she became pregnant, and her first pregnancy was tubal. Tubal pregnancy may follow normal gestation, or an abortion, within a few months, or it may occur as a first pregnancy in a woman of twenty or one of forty years of age. A Fallopian tube may become gravid in the newly married, or in the mother of a large family. Galabin has recorded a case in which, after an operation for a ruptured tubal gestation, a second normal child was born within a year from marriage. An analysis of a large number of cases establishes the view that the occurrence of tubal pregnancy is often preceded by a long interval of sterility. In the 133 cases investigated by Finsterer the average interval was seven years, and as in these women the course of child-bed had previously been normal, he concludes that an important factor in the causation must be anomalies in the fertilized ovum.

The frequency of the occurrence of an ectopic gestation is difficult to determine with certainty, since not all the cases are operated upon, and errors in diagnosis may well occur. Werth records 120 cases among 3600 gynaecological cases, or 3·3 per cent, of which 69 were operated upon. Among 3458 cases admitted to the women's ward in University College Hospital during the years 1902 to 1912 inclusive, there were 95 cases of tubal pregnancy and pelvic haematocoele, and of these 34 were operated upon with one death, and 61 were treated without operation with no deaths.

A tubal pregnancy occurs as often in one tube as in the other.

ANATOMY OF TUBAL PREGNANCY

Changes in the Wall of the Tube.—The changes which occur in the wall of the pregnant tube agree very closely in their main outlines with those which have been shown to accompany the embedding of the ovum in the uterus. It is now well known that the ovum embeds itself in the mucous membrane of the uterus by means of the destructive action of the cells of the trophoblast on the maternal tissues, and that its nourishment is carried on in the early days of its development by the absorption of nutritive material by these same cells. The old theory that an ovum could only become attached to decidua has been shown to be untrue, and the formation of the decidua instead of preceding the attachment of the ovum follows

it, and serves the function of keeping within limits the eroding action of the trophoblast. In all probability the formation of the implantation cavity, which is always larger than the ovum it contains, is due to the action of some cellular ferments secreted by the cells of the trophoblast rather than to any active invasion of the maternal tissues by these cells, a view which was held by most of the earlier writers on this subject, and which is indeed still maintained by some. The fact, however, that the destruction of the tissues and the liquefaction of the vessel-walls, leading to the escape of the blood contained within them into the intervillous spaces, can be observed to be taking place at some distance from the nearest trophoblastic cells is in favour of the process being of a chemical nature rather than a direct cellular action. In many places the vessel-wall is entirely destroyed and replaced by a layer of trophoblast which may protrude into the lumen of the vessel.¹ The tubal wall also is usually oedematous and softened for some distance from the site of the ovum.

It is possible for the fertilized ovum to acquire an attachment, as Werth has shown, to either the tip or the side of one of the plicae of the mucous membrane, the *columnar variety of attachment*, or to one of the depressions between two adjacent plicae, the *intercolumnar variety*. In the first variety the ovum may develop for some little time practically surrounded by the tubal mucosa, in the second it very quickly becomes embedded in the muscle-tissue as there is no sub-mucous layer in the tube. The changes in the tube are most marked in the immediate neighbourhood of the ovum. It is at first thickened, partly by hypertrophy of the muscle-elements, and partly by oedematous infiltration of the connective tissue between the muscle-bundles. If the tube-wall is examined in the neighbourhood of the ovum, in a typical case, the layers of longitudinal muscle will be seen to be separated from one another by a number of large cells with deeply-staining nuclei, some of the invading cells of the trophoblast. A section across an early gestation-sac will demonstrate that the ovum surrounded by a many-celled layer of ectoblast—the *trophoblast*—is situated in the muscle-layer of the tube-wall, bulging towards, but separated from, the lumen by a layer of tissue, the so-called *membrana capsularis* or *pseudo-reflexa* (see Plate IX. A).

The wall of the sac in the early stages is formed, except at this point, by a layer of muscle-tissue undergoing fibrinous degeneration, which infiltrated by numerous trophoblastic cells forms the so-called "cell-sheet." Wherever the muscle-fibres are in contact with, or in the immediate vicinity of, trophoblastic cells, they are undergoing a process of degeneration, which is spreading farthest along the veins in the tube walls. Besides the necrotic changes there is a very extensive

¹ James Young, *Reproduction in the Human Female*, 1911, p. 106.

formation of blood-sinuses, some no doubt derived from pre-existing sinuses with definite endothelial walls, and other false sinuses, due to destruction of the maternal tissues and the flooding of the spaces so formed with maternal blood.

Berkeley and Bonney¹ point out that as the trophoblast delaminates the muscle-wall along many concentric planes it follows that considerable areas of muscle-tissue become segregated off between the layers of foetal cells and undergo fibrinous change. The foetal sac is therefore bounded by layers of fibrin intermingled with trophoblastic cells, forming the so-called *Nitabuch's fibrin-layer*, and this is added to by the further deposit of fibrin from the maternal blood in the intervillous spaces.

When we consider the differences which exist between the uterine wall in which the ovum embeds itself and the tubal wall, it is not surprising to find that the latter is ill adapted to contain the ovum and very soon gives way. The hypertrophic changes in the wall of the tube are relatively slight, the mucous membrane is thin, there is no submucous tissue, and the result is that, when the ovum, as usually happens, becomes attached to the mucosa between two folds, it at once sinks into the muscle-tissue of the tube-wall. In its growth this tissue is soon destroyed, and as the numerous vessels contained in it are opened up, haemorrhages occur which lead to further destruction of the muscle, until at last the outer surface of the ovum is covered only by a thin layer of peritoneum, which in its turn gives way, resulting in the so-called rupture of the tube.

If the tubal wall is examined at a little distance from the site of the ovum, it will be seen that the tubal epithelium is intact over the greater part of its extent, but in some places it is proliferating and is several layers thick, and in other places it is desquamating. There is an extensive oedematous infiltration of the tissues, engorgement of the blood-vessels, with proliferation of the endothelial lining, here and there are interstitial haemorrhages, and an accumulation round the vessels of lymphocyte-cells and intermediate forms up to fully formed polyblasts (Wade and Watson²) (Fig. 193).

Throughout the entire extent of the affected tube irregularly-shaped sinus-like blood-vessels are found, with a distinct endothelial lining resembling the blood sinuses which develop in the wall of the uterus during ordinary pregnancy (Young). There is also swelling and hypertrophy of the connective-tissue cells and in some of the folds of mucous membrane a well-marked formation of decidual cells, closely resembling those found in the uterus and derived similarly from altered connective-tissue cells. The muscle-cells are hypertrophied, and near the site of the ovum,

¹ C. Berkeley and V. Bonney, "Tubal Gestation," *Journ. Obstet. and Gyn. Brit. Emp.*, 1905, vii. 77.

² H. Wade and B. P. Watson, *Journ. Obstet. and Gyn. Brit. Emp.*, 1908, xiv. 89.

between the layers of longitudinal muscle, collections of trophoblastic cells are generally to be found.

In some cases there appears to be an actual increase in the amount of connective tissue in the wall of the tube; this is most commonly seen when the ovum has been retained some time in the tube, but may be the result of an antecedent chronic salpingitis. Whether this is so or not, the connective tissue resists the bio-chemical



FIG. 193.—A section of a portion of the wall of a gravid tube, showing enlargement of the vessels and degeneration of the muscle-fibres.

destructive action of the cells of the trophoblast to a much greater degree than the muscle-cells.

The peritoneal epithelium is often altered in character, becoming cubical or cylindrical, and at times arranged in several layers. Small cellular projections may be present on the surface, or ingrowths, similar in character, into the underlying tissues of the tube. Werth, who first described these changes, thought that they were peculiar to cases of tubal pregnancy, but they may also be met with in cases of salpingitis.

When the ovum is situated in the ampullary portion of the tube, it gradually

narrows the lumen in its growth, converting it into a crescentic slit (Fig. 194), until at last it is entirely obliterated, the capsular membrane fusing with the mucous membrane of the opposite wall. In the isthmal portion of the tube the ovum tends rather to displace the lumen to one side, and the implantation cavity

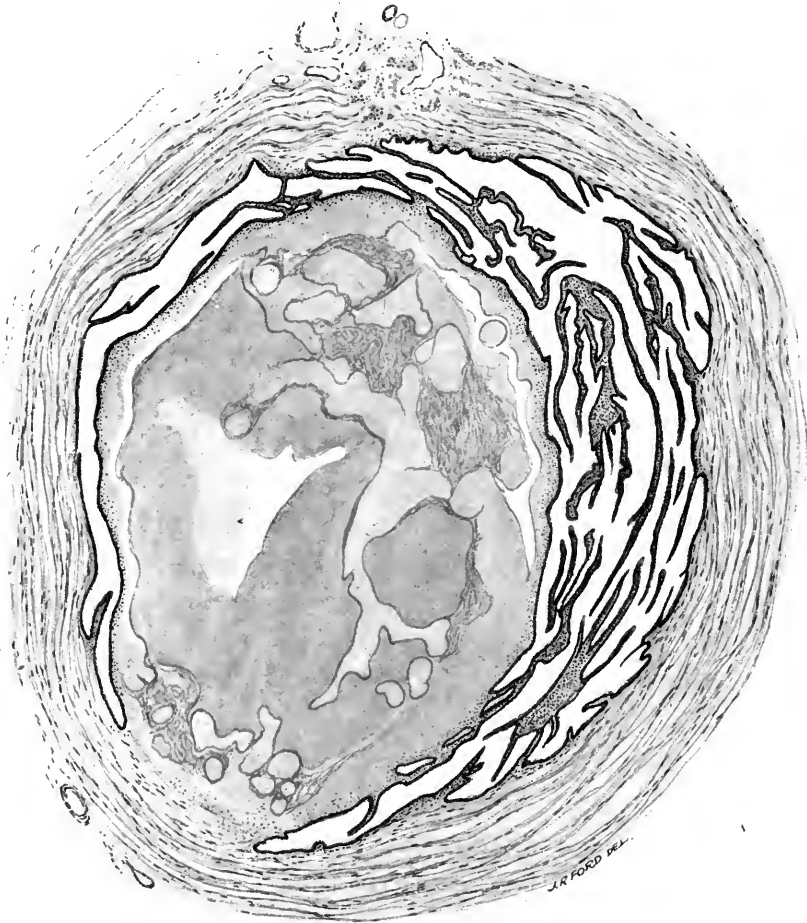


FIG. 194.—A section of the Fallopian tube from a case of early tubal pregnancy, showing the gestation-sac outside the lumen of the tube into which it is bulging.
(From a specimen lent by Dr. Cuthbert Lockyer.)

may eventually surround it altogether. Some fibres of this circular layer of muscle in the wall of the tube usually, however, remain round the lumen.

The membrana capsularis or pseudo-reflexa does not resemble the decidua reflexa or capsularis of the uterus. In many cases it is composed merely of a layer of fibrin, indicating the point at which the ovum became embedded in the tubal wall, while in other cases it consists of a layer of connective tissue with some muscle-

fibres and scattered through it a few decidual cells. When the ovum is situated in the ampullary portion of the tube, as it grows, the pseudo-reflexa finally fuses with the mucosa of the tube-wall. When it is in the isthmal part of the tube the effect of the surrounding of the tube-lumen by the developing embryonic cavity is at times such that the lumen appears as if it were attached to the wall of the tube by a pedicle.

In the early stages, as the growing ovum burrows its way beneath the layers of



FIG. 195.—Section showing the mode of attachment of the chorionic villi to the wall of the tube, with marked proliferation of the cells of Langhans' layer and of the syncytium, and fibrinous degeneration of the muscle.

muscle-fibre, some portion of the tubal mucosa may be raised up over it at the periphery, forming a covering of modified mucous membrane, somewhat similar to the decidua reflexa of an intra-uterine pregnancy. This layer is, however, quickly destroyed by the action of the trophoblast and persists but for a short time; its final destruction is often followed by what is termed intratubal rupture of the foetal sac.

The foetal portion of the placenta develops, in a tubal gestation, in the same way as it does in an intra-uterine. The attachment of the villi to the tubal wall

is effected by the proliferation of the cells of the trophoblast which invade the tubal wall, and can be seen lying between and beyond the superficial layers of muscle-tissue, which are converted into a fibrinous layer similar to Nitabuch's fibrin layer in the uterus (Fig. 195). Cells of Langhans' layer, and at times portions of the syncytium can be seen lying within the lumen of some of the vessels in the wall of the tube. Veit believes that this plays a part in the production of rupture of the capsule, as the masses of villi may plug some of the vessels, and by raising the pressure within them give rise to haemorrhages. This view receives strong support from Kiutsi,¹ who calls attention to the richness of the ovum in villi, many of which have a poorly developed stroma. The close relationship of the vessels of the villi to the large venous sinuses in the muscular wall of the tube, and the mobility of the tube itself, also play, in his opinion, a predisposing part in the production of rupture of the gravid tube.

The old view that the formation of a complete decidual membrane occurred in the tube comparable to that found in the pregnant uterus is no longer tenable. The amount of decidual reaction varies very largely in different cases, and has indeed not been found at all by some observers; thus Bland-Sutton found no sign of it in a study of twenty-five gravid tubes in the early weeks of pregnancy. It has, however, been described by so many competent observers that there can be no doubt as to its occurrence in most cases. As Russell Andrews² has pointed out, the amount of connective tissue in the tubal mucosa, especially in the portions between the plicae of the mucous membrane, is very scanty, and anything like the formation of a definite layer of decidua could not be expected. The connective-tissue cells, however, undoubtedly undergo in places a transformation into decidual cells, and these usually are seen best near the summits of the folds of the mucous membrane, and at some little distance from the attachment of the ovum (Fig. 196). It is indeed only rarely that decidual cells in any number are to be seen at the placental site. It is often difficult to distinguish in the tube, between the cells of Langhans' layer and decidual cells, but that the formation of decidual cells does occur is proved by the fact that they have been demonstrated in the non-gravid tube in cases of tubal pregnancy by Whitridge Williams, Webster, and others, and have also been demonstrated in the tube in cases of intra-uterine pregnancy, that is in conditions in which there could be no question of their foetal origin. If we are to accept the modern view that the function of the decidua is to limit the destructive action of the foetal cells, then its scanty development in a tubal pregnancy may be

¹ M. Kiutsi, *Arch. f. Gynaek.*, 1912, xcv. 487.

² H. Russell Andrews, *Journ. Obstet. and Gyn. Brit. Emp.*, 1903, iii. 419.

correlated with the large amount of damage inflicted upon the tissues by the growing ovum.

In many cases, especially when the ovum is lodged in the ampulla of the tube, the abdominal ostium remains open for some six to eight weeks, and then gradually becomes closed by a process analogous to that occurring in cases of salpingitis. When the attachment of the ovum is in the isthmal or interstitial portion of the tube, the abdominal ostium is usually unaffected. In some cases, however, the

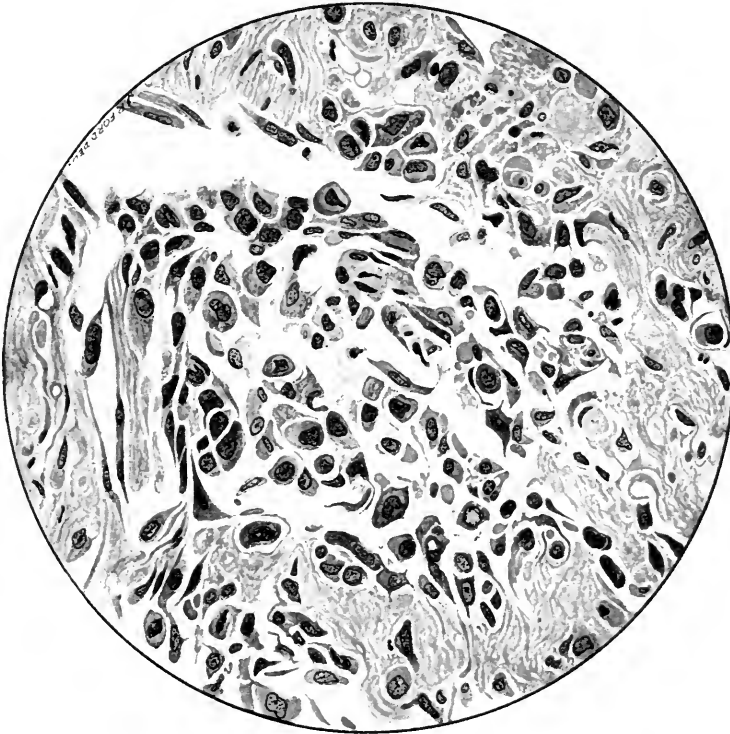


FIG. 196.—Decidual changes in the mucous membrane of a gravid tube.

abdominal ostium remains widely open. The uterine orifice of the tube is closed by the swelling of the mucosa, but microscopic examination shows that it is not actually occluded.

Changes in the Uterus.—The changes which occur in the uterus in cases of ectopic gestation are in part due to the increased pelvic circulation, and in part to the presence in the blood of substances of unknown composition which determine, for example, the changes in the breasts and the secretion of the milk. The uterus increases usually, to the size of the organ at the second or third month of pregnancy, but it may measure as much as five inches in length, and the sound may pass some $4\frac{1}{2}$ inches. This is due to hypertrophy of all the elements in the uterine wall.

There is increased growth of the muscle-tissue, and of the connective tissue, and there are changes in the mucosa analogous to those occurring in intra-uterine pregnancy (Fig. 197). The formation of the uterine decidua may begin in the early weeks of pregnancy, or may be delayed in some cases until two or three months have elapsed. The intensity of the changes in the uterus have been described as dependent upon the nearness of the foetal sac to the uterine wall, but this does not appear to be proved. In the mucous membrane well-developed decidual cells



FIG. 197.—Section of the uterine decidua in a case of tubal pregnancy.

are formed, hypertrophy and dilatation of the glands takes place; there is also a division of the membrane into a compact and a spongy layer, just as in an intra-uterine pregnancy, with the difference that the change is limited mainly to the superficial layers of the mucosa, and the spongy layer is usually poorly developed. In the majority of the cases (on the termination of the pregnancy either spontaneously or artificially), the decidual membrane is discharged in the form of shreds, or large pieces, or as a more or less complete cast of the uterine cavity. A complete cast consists mainly of the superficial layer of the mucosa; it is triangular in shape and presents three openings corresponding to the openings of the tubes and the internal

os (Fig. 198). The outer surface of the cast (the separation generally occurring in the outer portion of the ampullary layer) is shaggy and rough, the inner surface presents folds and furrows similar to those seen in the mucous membrane of the uterus in early pregnancy. Microscopical examination shows well-marked decidual cells (Fig. 199), enlargement of the glands with an arrangement of the gland-spaces parallel to the surface in the deeper portions of the mucosa, frequently marked engorgement of the blood-vessels, and an oedematous infiltration of the whole tissue (Cazeaux).¹ The glandular epithelium is usually present, cylindrical in character in the deeper portions of the glands, flattened in the superficial portions. If the pregnancy advances to the later stages, definite softening of the cervix may be



FIG. 198.—A complete cast of uterine decidua from a case of ectopic gestation. (U.C.H. Med. Sch. Museum, No. 720.)

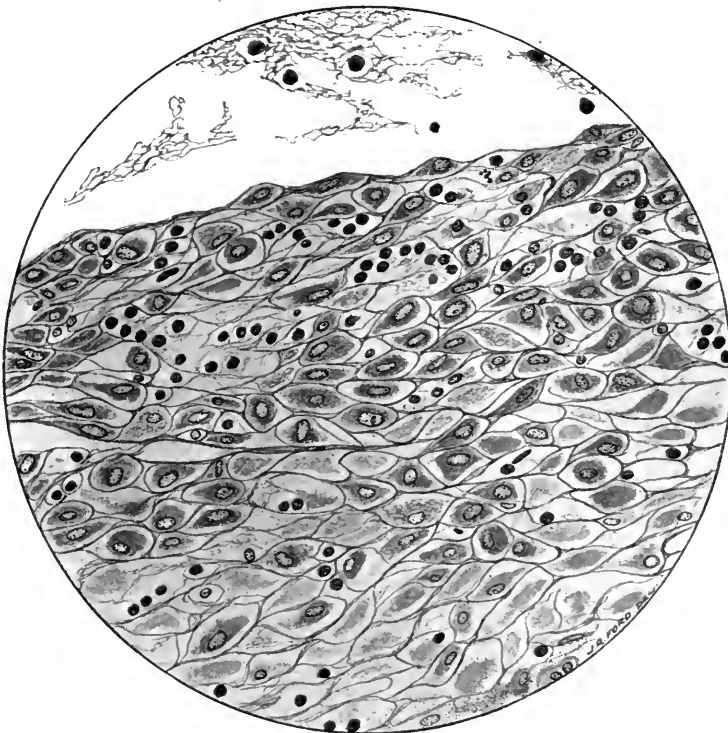


FIG. 199.—A section of a cast of uterine decidua from a case of tubal pregnancy.

¹ P. Cazeaux, *Annales de Gyn. et d'Obstét.*, 1904, s. 2, vol. i. 85.

present, and purple discoloration, both of the cervix and of the vagina. Enlargement of the uterus is not always to be recognized at the time the patient is seen, as the development of the extra-uterine pregnancy may already have ceased, or the patient may not come under observation until the uterus has had time to undergo involution.

TERMINATIONS OF TUBAL PREGNANCY

Tubal Abortion and Tubal Mole.—A tubal pregnancy may terminate in a variety of ways. The ovum may die at an early period, and become completely absorbed without giving rise to any symptoms; haemorrhage may occur into the tube, the abdominal end becoming closed, forming a haematosalpinx; the pregnancy may terminate by the sac bursting into the lumen of the tube, followed by the complete or partial extrusion of the ovum through the abdominal opening, ‘tubal abortion’; or more rarely, the sac may burst through the wall of the tube, ‘tubal

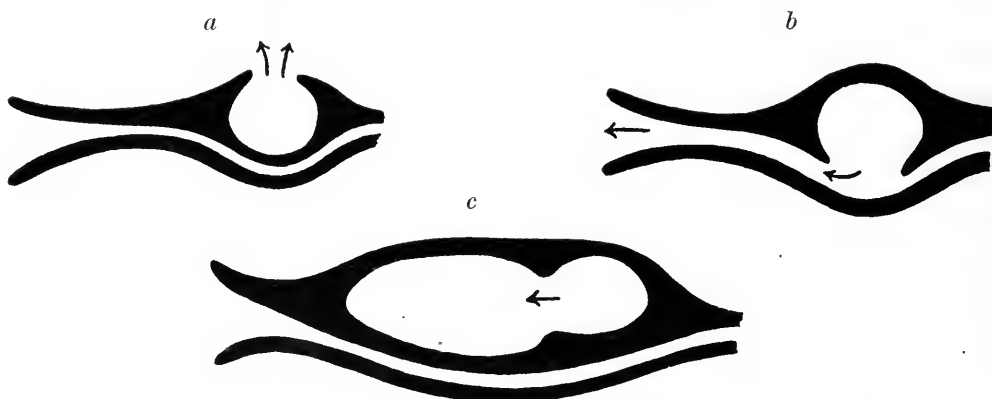


FIG. 200.—Diagrams showing (a) extratubal (intraperitoneal) rupture; (b) intratubal rupture; and (c) intramural rupture of a tubal gestation-sac. (Berkeley and Bonney.)

rupture’; or lastly, it may go on developing into the second half, or even to the end of pregnancy.

The commonest termination is the bursting of the sac into the lumen of the tube, and the occurrence of a tubal abortion (Fig. 200, b). This occurs more commonly than rupture of the wall of the tube, because the membrana capsularis or pseudo-reflexa is thin and readily destroyed by the erosive action of the cells of the trophoblast. The actual bursting of the foetal sac is due to haemorrhage into its interior from blood-vessels opened up by an increase in the blood-pressure, or by some actual trauma, such as a fall, a blow, coitus, or a pelvic examination. Obviously the rupture of the sac into the tubal lumen can only occur when the lumen is still present. At first the bleeding no doubt takes place into the wall of the sac, or

into the tissue between the chorionic villi and the tubal wall (the chorio-decidual space), but it may also occur into the cavity of the sac, and in some cases, not infrequently according to Berkeley and Bonney, the blood is extravasated between the layers of longitudinal muscle-fibre of the wall of the tube, forming a so-called intramural rupture (Fig. 200, c). In most cases some of the blood escapes into the lumen of the tube and finds an exit into the peritoneal cavity by the patent *ostium abdominale*. If the haemorrhage is due to the opening up of a large vessel the bleeding may be so severe as to cause destruction of the ovum, its complete separation from the tubal wall, and its discharge into the peritoneal cavity—*complete tubal abortion*.



FIG. 201.—Tubal mole in process of detachment; from a case of incomplete tubal abortion. (Royal College of Surgeons Museum, No. 441A.)



FIG. 202.—A tubal mole showing a foetus three-quarters of an inch in length. Below is seen the cut surface of the ovary, and more to the left the lumen of the Fallopian tube cut across. (Alban Doran.) (From a specimen in the Museum of the Royal College of Surgeons.)

More commonly the ovum is first converted into a *tubal mole* by the deposit of blood in successive layers in its interior and on the sac-wall, which subsequently undergoes fibrinization and decolorization. The mole, gradually increasing in size, and distending the tube, progresses in the direction of least resistance and tends ultimately to be extruded through the abdominal ostium (Fig. 201). Not uncommonly this process of extrusion is accompanied by renewed haemorrhages both into the mole and around it, and some of the blood escapes into the peritoneal cavity.

Here peritonitis is set up with the formation of adhesions which form a false capsule round the blood, converting it into a so-called *peritubal haematocoele*, in the middle of which the remains of the embryo may be detected.

The main characters of a tubal mole have been well described by Bland-Sutton from a study of 130 specimens. Tubal moles vary greatly in size; some have a diameter of 1 cm., others of 5 or 8 cm., and on rare occasions they are even larger.

Small moles are globular, but after attaining a diameter of 3 cm. they assume an ovoid shape. The amniotic cavity usually occupies an eccentric position (Fig. 202). Sometimes an embryo is present, often it is mal-developed or deformed. In many specimens the amniotic cavity has ruptured and the embryo has disappeared. On the outer surface of the mole the remains of chorionic villi can often be recognized. Recent moles are dark red, resembling blood-clot (Plate IX. A), but when they have

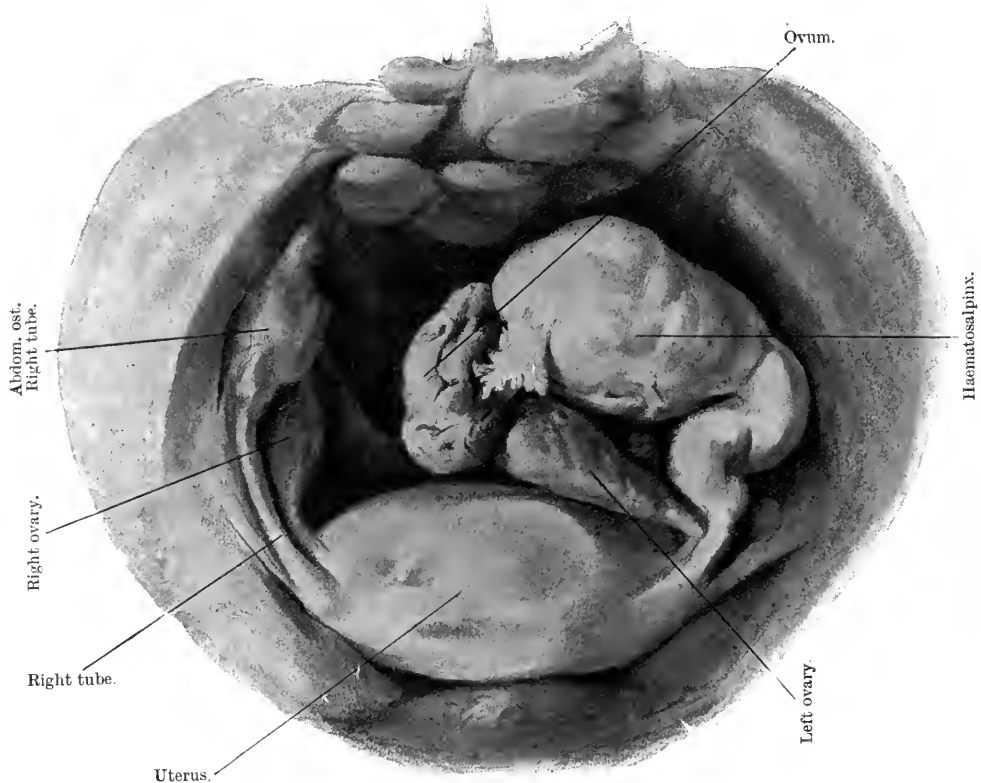


FIG. 203.—Complete tubal abortion with a haematosalpinx and peritubal haematocele. (From Bumm.)

been retained some time in the peritoneal cavity or between the layers of the broad ligament, they are firm and hard and of a lighter yellow colour. In a doubtful case, in which the amniotic cavity cannot be recognized, a microscopical examination will generally show the presence of chorionic villi. In some cases, where the mole is not of large size, the external capsule is formed by the chorion, but more commonly the chorionic membrane has been broken up by the haemorrhage, and the villi are found scattered throughout the substance of the blood-clot. Bland-Sutton believes that the blood lying within the chorion is derived from the foetus; this may be so

in part, but the great mass of it is certainly of maternal origin, and is situated not within, but diffused throughout and external to, the chorion.

The escaping blood coagulates round the end of the tube and as a result of the repeated haemorrhages the tumour grows larger and larger, until at length the tube lies embedded in a rounded mass consisting of coagulated blood and forming a typical *peritubal haematocele* (Fig. 204). As

the result of further haemorrhage, which tends to continue so long as the mole remains in the tube, the effusion grows larger still, the increase in size being permitted either by the rupture of the imperfectly formed capsule, which at first may consist merely of the outer layer of the coagulated blood, or by the stretching of this capsule.

In this way the tumour grows until at last it fills up the posterior portion of the pelvic cavity more or less completely. Most commonly a pelvic haematocele is behind and to one side of the uterus, but in some cases it extends up over the pelvic brim and may even lie in the iliac fossa. At first the outline is indistinct, but as the capsule becomes formed and the outer layers of blood clot firmly, it becomes more definite in outline, and more easily felt. It is usually markedly adherent to surrounding structures, such as the uterus, the

back of the broad ligament, the side wall of the pelvis, and the large or small intestine. With the increased firmness of the swelling goes a gradual increase of mobility, the tumour generally moving to some extent with the uterus to which it is attached. At first the consistence is that of blood-clot, but as the blood-clot solidifies it becomes distinctly harder, and this gradual change from an elastic to a solid feel is very characteristic of these tumours. Occasionally the blood in the centre remains quite fluid, so that the resemblance to a thick-walled cyst is very great.

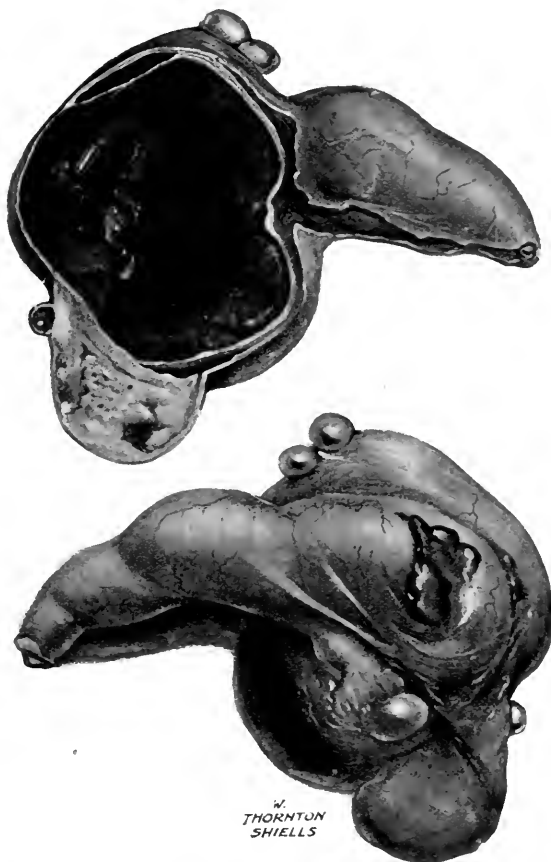


FIG. 204.—An encysted peritubal haematocele; a glass rod has been passed into the abdominal end of the tube. (Cuthbert Lockyer.)

In the rare instances in which the blood escapes into the cellular tissue of the broad ligament the physical signs resemble those seen in cases of pelvic cellulitis. At first the tumour is attached to the side of the uterus, but as it extends it may form a ring round the cervix, or may spread round the anterior surface of the rectum, and extend out to the side wall of the pelvis. These tumours are usually harder than intraperitoneal haematocoeles as the blood clots more quickly.

In a few cases when the mole is of small size it may become absorbed

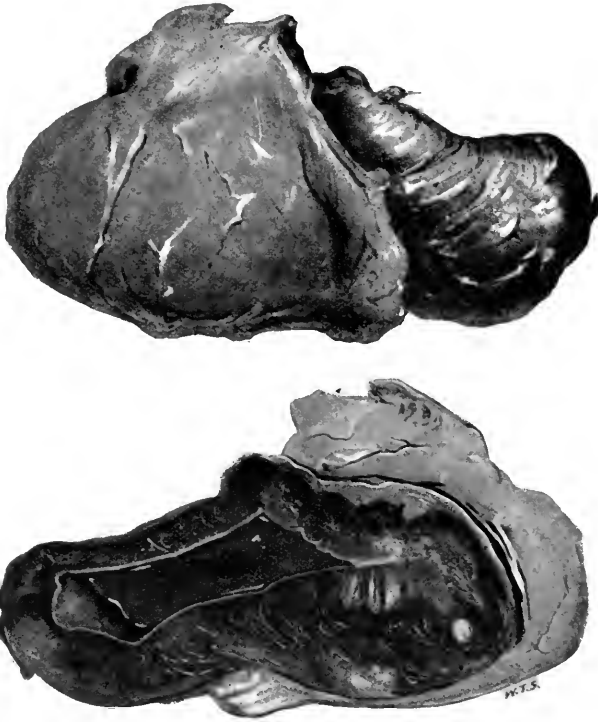


FIG. 205.—A tubal mole in process of expulsion. (Royal College of Surgeons Museum, No. 443.) (See Alban Doran, *Journ. Obst. and Gyn. Brit. Emp.*, 1906, x. 621.)

while still within the tube. Its expulsion from the tube is brought about in the great majority of instances by continued haemorrhage taking place behind it. It is very doubtful if contractions of the tube wall play much, if any, part in the expulsion, but that they do occur seems to be shown by the cases of intussusception of the tube which have been recorded by Mainzer¹ and Bertino.²

The passage of the tubal mole through the abdominal ostium, like a uterine abortion, is accompanied by haemorrhage (Fig. 205). Occasionally this is excessive, and gives rise to symptoms resembling those of a tubal rupture, but more commonly it

is slight in amount, and in the incomplete abortion constitutes what has been termed a "blood-drip" by Taylor, which forms a typical peritubal haematocoele, ample time being allowed for the formation of adhesions around the effused blood. As Bland-Sutton points out, in many cases this capsule, which encloses and surrounds the abdominal ostium, is so perfect that the haematocoele can be removed entire.

An incomplete tubal abortion is commoner than a complete one, because the

¹ Mainzer, *Zentralbl. f. Gynaek.*, 1903, No. 30, 921.

² Bertino, *Annali di Ostet. e. ginecologia*, 1909, xxxi. 447. See, too, von Strauch, "Zur Frage der Tubenwehen," *Zentralbl. f. Gynaek.*, 1899, No. 42, 1294.

attachment of the chorion to the tube-wall, in the absence of a well-formed decidua, is firmer than is the case in an intra-uterine pregnancy. Portions of the ovum are therefore very constantly retained, giving rise to continued haemorrhage and the formation of a tubal placental polypus. Not infrequently, when the abdomen is opened the mole can be recognized partly extruded from the abdominal ostium (Fig. 206).

If the primary haemorrhage is more severe, the escaping blood fills up the pouch of Douglas at once, forming a typical *retro-uterine haematocoele*, or it may even cover over the uterus, or fill the vesico-uterine pouch, forming the so-called *supra-uterine* or *ante-uterine haematocoele*. In a typical case of a well-marked retro-uterine haematocoele, the uterus is pushed upwards and forwards against the abdominal wall, and the symphysis pubis (Fig. 207); in other cases it is pushed over to one side by a laterally placed tumour, or is retroverted below and behind the effused blood. The rectum is pushed backwards and to the left, and its lumen may be narrowed. The upper limit of a haematocoele is usually formed by coils of adherent intestine matted together, roofing over the tumour and shutting it in. Between the coils lie darkish masses of blood-clot and fibrin, and the peritoneum, both visceral and parietal, usually shows signs of pigmentation. In old haematocoeles the outline may be well defined, and the collection of blood is bounded by numerous dense adhesions formed with neighbouring organs. The consistence of the tumour varies with its age; in recent cases it is soft and elastic, and in some cases fluctuation can be demonstrated. After a time the blood coagulates, the tumour acquires a more solid feel, and the gradual transition from a fluid to a semi-solid consistence is extremely characteristic of these collections of blood. At times the fluid character persists, and the resemblance then to a cystic tumour may be very marked.

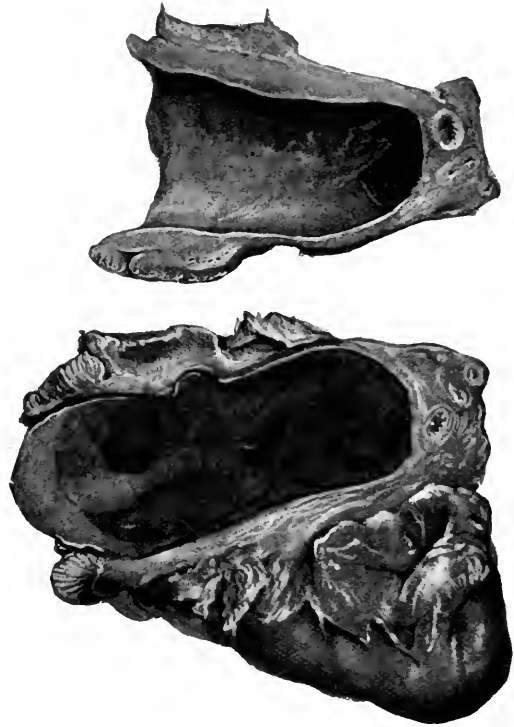


FIG. 206.—A section of a Fallopian tube showing a tubal mole in the process of extrusion through the abdominal ostium. The upper drawing shows the degree of dilatation of the tube and ostium. (J. Bland-Sutton.) (From a specimen in the Museum of the Royal College of Surgeons.)

Tubal Rupture.—Much less common, but much more serious, than bursting of the gestation-sac internally, is its rupture through the wall of the tube—true *tubal rupture*. This occurs most frequently through the part of the tube covered by

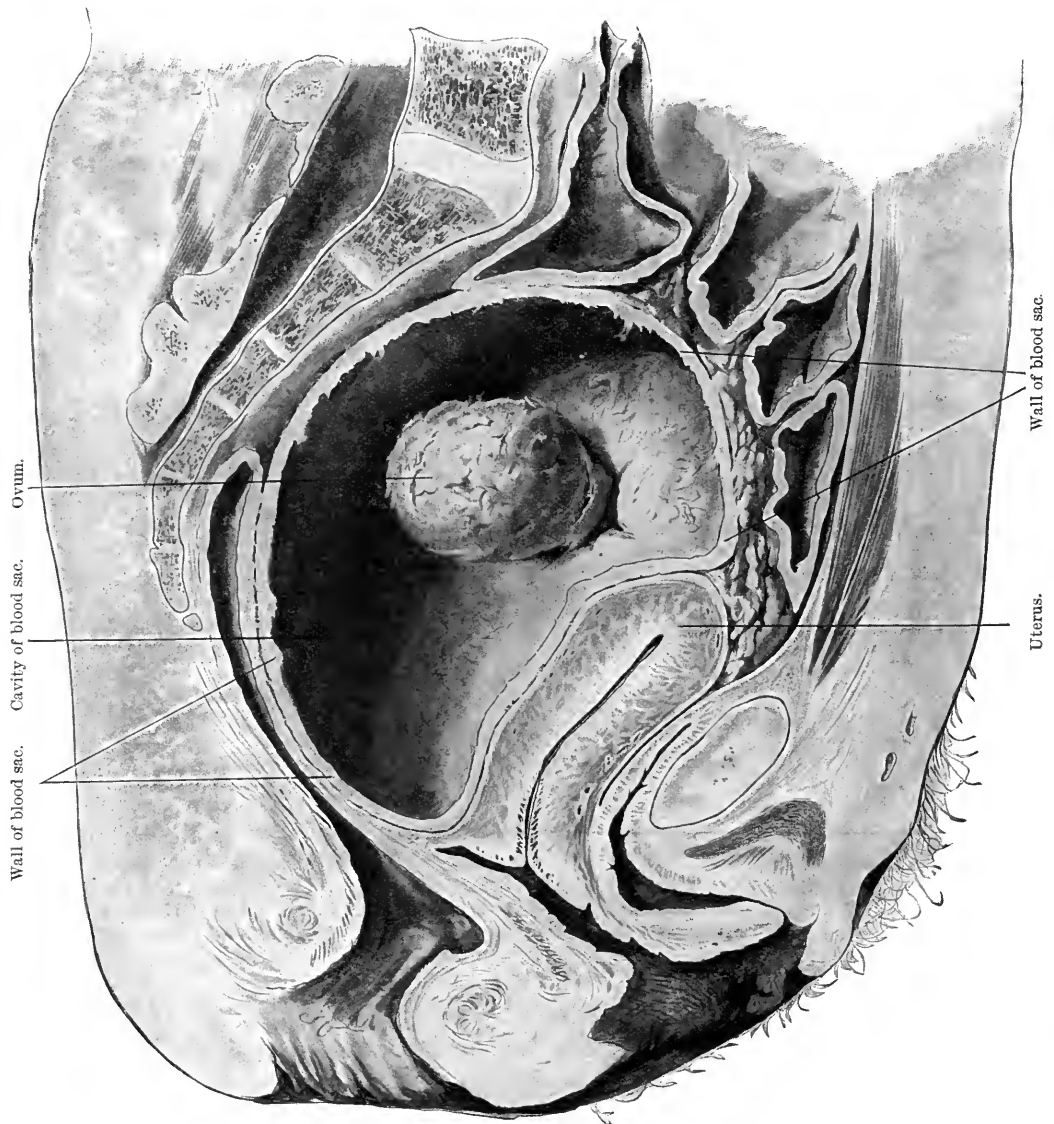


FIG. 207.—A sagittal section of a retro-uterine haematocoe. (From Bunm.)

peritoneum into the peritoneal cavity, *primary intraperitoneal rupture* (Fig. 208), while in a few cases the rupture occurs between the layers of the broad ligament, *extra-peritoneal rupture*, forming a so-called *broad-ligament gestation*, or if the pregnancy comes to an end, a *broad-ligament haematoma*.

Intraperitoneal rupture of the sac, like that occurring into the tubal lumen, is brought about by the gradual destruction of the tissues by the cells of the trophoblast, while the actual tearing of the tissues is produced by a haemorrhage, the result of the opening of a large vessel, or of some trauma inflicted upon the sac itself. In most of the cases rupture occurs after the abdominal ostium has become closed, but it may take place at an early period of the pregnancy before this has occurred (Fig. 209). Intraperitoneal rupture may accompany or follow an internal rupture with the formation of a mole, or an intramural rupture may burst secondarily through the wall of the tube into the peritoneal cavity.

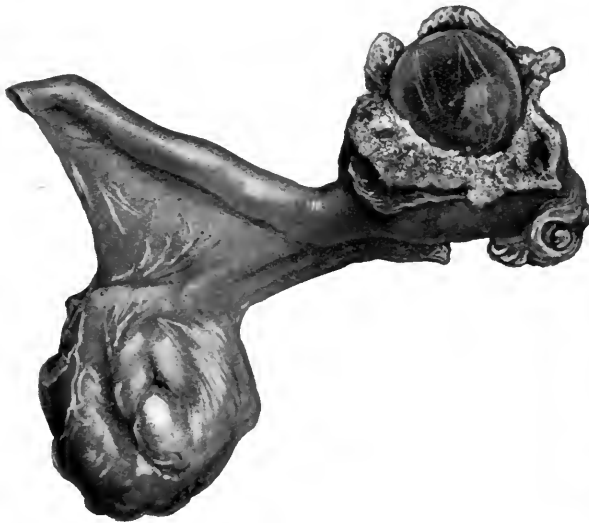


FIG. 208.—Right Fallopian tube with intraperitoneal rupture of a gestation-sac, the amnion being intact. (Royal College of Surgeons Museum, No. 459A).



FIG. 209.—A ruptured pregnant tube and cystic ovary, with a mass of chorionic villi hanging out through the rupture. (U.C.H. Med. Sch. Museum, No. 695.)

The opening in the tube may be in the form of a definite rent, a perforation the result of a gradual erosion of the tissues, or a small opening, of which there may be one or several. A careful examination of tubes removed for tubal pregnancy demonstrates not infrequently that some of these minute perforations have been occluded secondarily by blood-clot or by adhesions.

The quantity of the effused blood may amount to two litres or more. The amount of the bleeding is usually quite out of proportion to the size of the opening, and this has been attributed to the secretion of an anti-thrombin by the epithelium of the chorionic villi. Rupture of the tube takes place more frequently with an

isthmal pregnancy than with an ampullary. In the former there is less space in the tube for the ovum to develop; it has also been suggested by Berkeley and Bonney that the circular muscle of the wall of the tube offers less resistance than the longitudinal layer to the destructive action of the trophoblast, and as in the isthmal portion of the tube the circular layer is particularly well formed, the trophoblast, growing outwards, soon reaches the periphery of the tube.

Rupture of the tube may, however, occur in the ampullary variety (Fig. 210), but usually at a somewhat later date. The area of the wall which bursts is commonly that at which the chorionic villi are attached to the tube, or the thinnest part of the tube-



FIG. 210.—A ruptured early tubal pregnancy situated about one inch from the abdominal end of the tube. (Univ. Coll. Hospital Medical School Museum.)

wall, but this is not constant, and the rupture may be at some little distance from this point. Werth describes a curious case in which the site of the rupture to which a tubal haematoma had become adherent was in an area on the opposite wall of the tube. The effect of the rupture upon the ovum varies; in some cases it is expelled into the peritoneal cavity entire, in other cases a portion of it may be retained in the tube, and the opening may be partly blocked by detached chorionic villi, while in other cases the whole may be retained in the tube.

The usual immediate result of an intraperitoneal rupture is the inundation of the peritoneal cavity with blood, and possibly the death of the patient from the haemorrhage. In some cases she survives the first attack of bleeding only to succumb to a later one. The blood accumulates

mainly in the cavity of the true pelvis, and in the flanks, but may be found diffused among the coils of intestine. When limited by adhesions of omentum and intestines at the brim of the pelvis, it may collect in Douglas' pouch, displacing the uterus upwards and forwards, and forming the so-called retro-uterine haematocele. Occasionally a tubal abortion gives rise to such a flooding of the peritoneum with blood, but the more usual result is the formation of a peritubal haematocele. Handley¹ has described what he terms a *paratubal haematocele*, due to the clotting and encapsulation of the blood round a small opening in the wall of the tube, which has resulted in only a moderate amount of bleeding.

¹ W. Sampson Handley, *Trans. Obst. Soc. Lond.*, 1902, xliv. 325.

OVARIAN PREGNANCY

Of late years a number of cases of this variety of ectopic gestation have been recorded, which conform to the requirements laid down by Spiegelberg as necessary for their acceptance as proved instances. These conditions are : (1) The absence of the ovary in question. (2) The presence of well-marked ovarian structures in the wall of the foetal sac. (3) The connection of the latter with the uterus by means of the ovarian ligament. (4) The fact that the tube plays no part in the formation of the sac, and that its anatomical relations to the sac are the same as those met with in the case of an ovarian cyst (Fig. 211).

Whitridge Williams agrees with these requirements, but Werth considers that a gestation may be considered as ovarian in origin, when the sac is connected with the broad ligament and uterus like a tumour of the adnexa, and the Fallopian tube and ovarian fimbria can be shown to take no part in the formation of the sac, the possible presence of an accessory tube being at the same time excluded. It is obvious, that in any case of tubal pregnancy which has progressed

beyond the early stages, it may be possible to find ovarian tissue at some portions of the wall. If the conditions laid down by Spiegelberg are present, a case may be diagnosed as one of ovarian pregnancy without a microscopical examination.

Many cases have been described by the older writers, and a belief in ovarian pregnancy can be traced back more than two hundred years, but a critical examination shows that in most instances they were in reality cases of ovarian dermoids, or extra-uterine foetuses in the broad ligament. The case published by Catherine van Tussenbroek in 1899¹ was the first in which the presence of an ovarian pregnancy was proved with certainty. The patient was thirty-one years of age, and the last period

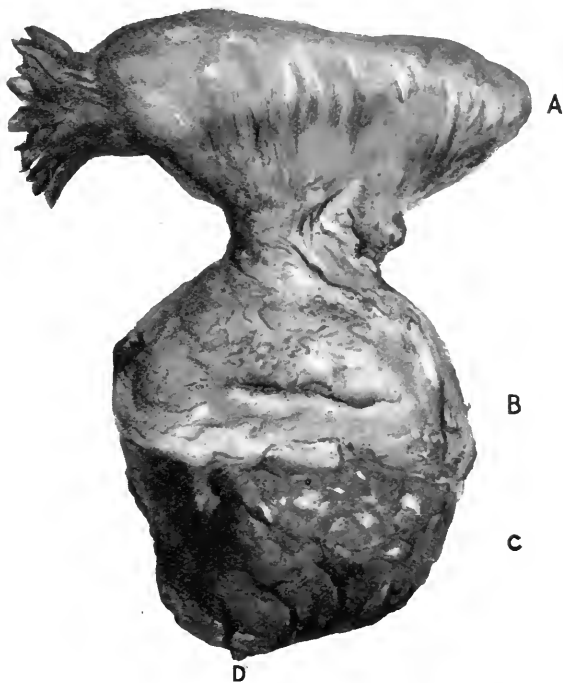


FIG. 211.—Ovarian pregnancy. A, tube ; B, ovary ; C, ovum ; D, rupture.
(J. M. Munro Kerr.)

¹ C. van Tussenbroek, *Annales de Gyn. et d'Obstét.*, 1899, lii. 537.

had occurred six weeks before. Kouwer of Haarlem performed abdominal section on account of signs of severe intra-abdominal bleeding. A swelling was found in the right ovary which was quite separate from the tube on the same side. Sections of the sac showed a partially macerated embryo 12 mm. in length, in which the head, the caudal extremity, and the commencement of the limbs could be seen. The sac lay within a corpus luteum, and the entire ovum was surrounded by villi, outside which was a layer of fibrin uniting them with the maternal tissues. From the fourth to

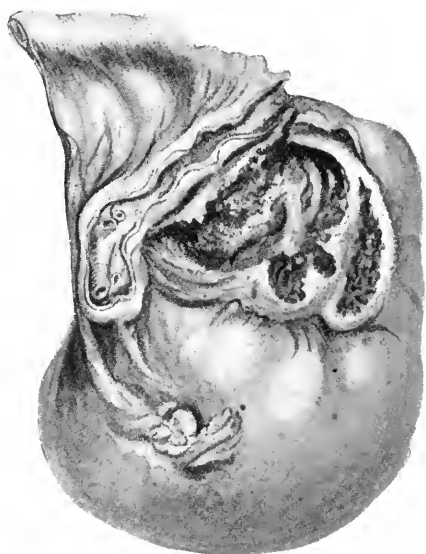


FIG. 212.—Ovarian pregnancy, anterior surface. The site of rupture is immediately beneath the two cut edges of the broad ligament. (Eardley Holland.)



FIG. 212A.—The same, showing a capsule of stretched ovarian tissue enclosing blood-clot, in the centre of which lies the gestation-sac. (Eardley Holland.)

the seventh day after the operation fragments of decidual membrane were passed from the uterus.

In the microscopical examination of an ovarian pregnancy, ovarian tissue should be present at several places in the wall of the sac, so as to exclude the possibility of its being a case of tubal or broad-ligament gestation, in which the ovary has become incorporated with the wall of the sac and flattened out on it, and sections of the tube should fail entirely to show any signs of such changes as are met with in cases of tubal pregnancy.

An ovarian pregnancy most commonly results from the fertilization of the ovum in the Graafian follicle. Leopold suggests that in some instances a more deeply situated follicle may burst into a superficial one, and the ovum of the first not being

expelled may be fertilized *in situ* by a spermatozoon, which has gained access to it through the superficial follicle. This would explain cases in which the ovum appears to be deeply embedded in the interior of the ovary (Fig. 212A). In a few cases the ovum appears after fertilization to have burrowed into the substance of the ovary from the follicle (Teacher, Bryce, and Kerr¹), and in others to have invaded the ovary from its surface (*epi-ovarial variety* of Schickele, see Fig. 213).²

In a case described by Busalla³ the ovum was implanted upon the surface of the ovary close to the site of the rupture of the follicle. The tunica albuginea, in which the ovum had primarily been embedded, had become necrotic, and had been pushed before the developing sac like a decidua capsularis. The tube was quite normal. Further proof is required of the suggestion that every ovarian pregnancy begins in a Graafian follicle, and this would be furnished if it could be shown that every ovum was originally situated in a follicle surrounded by a layer of lutein cells of the same age (Mall and Cullen).⁴



FIG. 213.—Epi-ovarial pregnancy. (Clifford White.)

When the seat of a gestation, the ovary undergoes hypertrophy, the blood-vessels become considerably enlarged, and intervillous blood-spaces form. Practically all observers are agreed that there is no formation of decidual cells, although cells are found here and there somewhat resembling them (Teacher, Bryce, and Kerr), and this negatives the suggestion that an ectopic gestation can only occur on tissues which have undergone some genetic influence. Webster, however, believes that the occasional occurrence of small localized areas of decidua-like cells in the ovary (which he maintains are probably Müllerian in origin) may determine the embedding and growth of a fertilized ovum in this situation, and that

¹ T. H. Bryce, J. H. Teacher, J. Munro Kerr, *Early Development and Imbedding of the Human Ovum: An Early Ovarian Pregnancy*, 1908.

² G. Schickele, *Beiträge z. Geb. u. Gyn.*, 1907, xi. 317.

³ Busalla, *Arch. f. Gyn.*, 1907, lxxxiii. 612.

⁴ F. P. Mall and E. K. Cullen, *Surgery, Gynecology, and Obstetrics*, 1913, xvii. 698.

this finding serves to support the dictum that the fertilized ovum in the human female begins its development in Müllerian tissues.

The formation of the implantation cavity is very similar to that in the uterus; the villi lie bathed in blood and separated from the tissue of the ovarian stroma by a layer of fibrin, Nitabuch's fibrin layer. Between the villi and the maternal tissues lie the intervillous spaces.

Nothing resembling a tubal abortion can take place in an ovarian pregnancy.

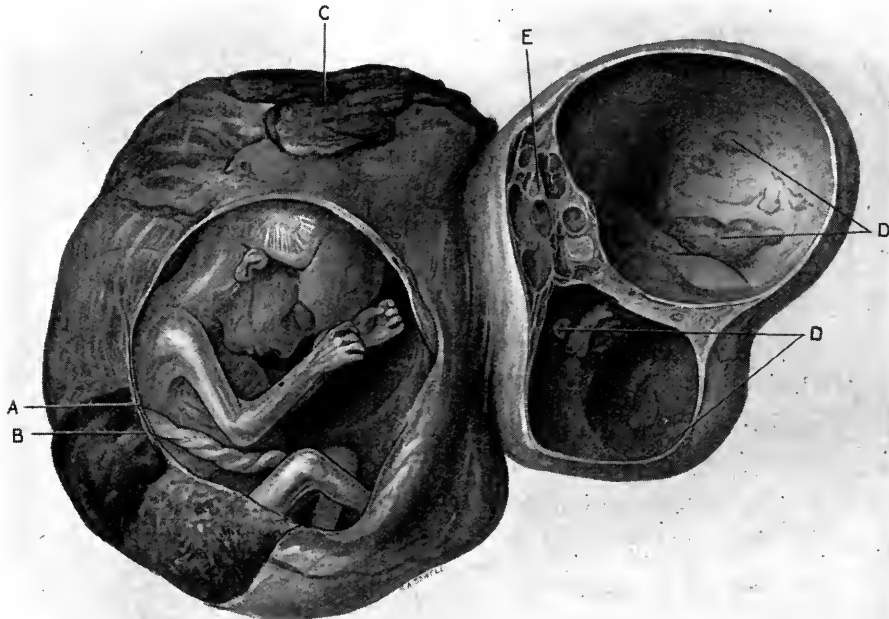


FIG. 214.—A primary ovarian pregnancy at the fourth month, occurring in an ovary the seat of cystic disease. A portion of the cyst-wall has been removed as well as the anterior wall of the foetal sac.

A, The amniotic lining of the foetal sac; B, the sac-wall including the chorion; C, recent blood-clot; D, intracystic growths; E, small cystic cavities, some containing adenomatous growths. (F. J. McCann.)

In many cases intracapsular haemorrhage probably occurs, with death of the ovum and the transformation of the sac into a haematoma, with possibly an amniotic cavity in the centre. We may expect that in the future a number of the cases hitherto described as ovarian haematomata will turn out to be cases of ovarian pregnancies. Early rupture occurs in the great majority of the cases, but this may not take place until the middle period of the pregnancy, and cases have been recorded of an ovarian pregnancy advancing to full term. The cases of Gottschalk¹ and Ludwig² are

¹ Gottschalk, *Zeitschr. f. Geb. u. Gyn.*, 1902, xlvii. 488.

² Ludwig, *Wiener klin. Wochenschr.*, 1896, ix. 600.

regarded as certain by Whitridge Williams. The formation of a lithopaedion occurs in a relatively large number of cases, but the explanation of this is doubtful. Werth regards the ovary as a favourable site for the implantation of the ovum, as there is room in the follicle for its early development, the tissues are vascular, and do not offer any great resistance to the development of the sac. This view, however, is not generally held. As in a tubal pregnancy, the uterus enlarges, and a decidua forms which is usually expelled soon after the death of the foetus.

Whitridge Williams collected the cases of ovarian pregnancy in the literature up to July 1906, and classified 35 cases as certain, highly probable, or probable examples. In 11 of these the pregnancy went on to full term, and a considerable proportion of them gave rise to lithopaedion formations. Since that time a number of observers have recorded cases which fulfil Spiegelberg's requirements, and among those published in this country or America may be mentioned the cases of Grimsdale, Graham, Eardley Holland, Bankes, Young and Rhea, Lea, Hastings Tweedy, Norris, Webster, Munro Kerr, McCann, Cullen, Giles and Lockyer.¹ Olga Serebrenikowa² collected 37 cases (1912), but many of these are certainly not proved cases of ovarian pregnancy, and the one published by Smith and Williamson which she includes is an example of cornual pregnancy.

In a case described by Engelking³ the pregnancy had apparently gone on developing between the layers of the broad ligament. The case is, however, one about which there may be some difference of opinion as to its site of origin.

HAEMATOCELE

A common sequela of an ectopic gestation is a pelvic haematocoele. This may be defined as an extravasation of blood into the peritoneal cavity, or into the cellular tissue of the pelvis, owing its origin to some disease of the pelvic organs. The extra-peritoneal variety, in which the blood is situated in the cellular tissue, is sometimes called a *pelvic haematoma*. From their anatomical relations haematocoeles are distinguished as peritubal, paratubal, retro-uterine, ante-uterine, peri-uterine, and supra-uterine.

Etiology.—Cases of pelvic haematocoele may be divided as regards their causation into those due to ectopic gestation and those due to other conditions. The first variety largely preponderates. In 25 cases recorded by Cullingworth⁴ 24 were due

¹ A. E. Giles, and Cuthbert Lockyer, *Proc. Roy. Soc. Med. Lond.*, 1914, viii. Pt. ii. 2.

² O. Serebrenikowa, *Arch. f. Gyn.*, 1912, xeviii. 525, with literature.

³ E. Engelking, *Monatsschr. f. Geb. u. Gyn.*, 1913, xxxvii. 740.

⁴ Cullingworth, *Clinical Illustrations of the Diseases of the Fallopian Tubes and of Tubal Gestation*, London, 1895.

to tubal pregnancy, the remaining case being due to the rupture of a broad-ligament cyst, curiously enough associated with a tubal gestation. According to Fehling the cause is a tubal pregnancy in as many as 90 to 95 per cent of all the cases. Fritsch has never seen a case in which the presence of a tubal pregnancy could be excluded with absolute certainty, and Schauta has observed the condition only

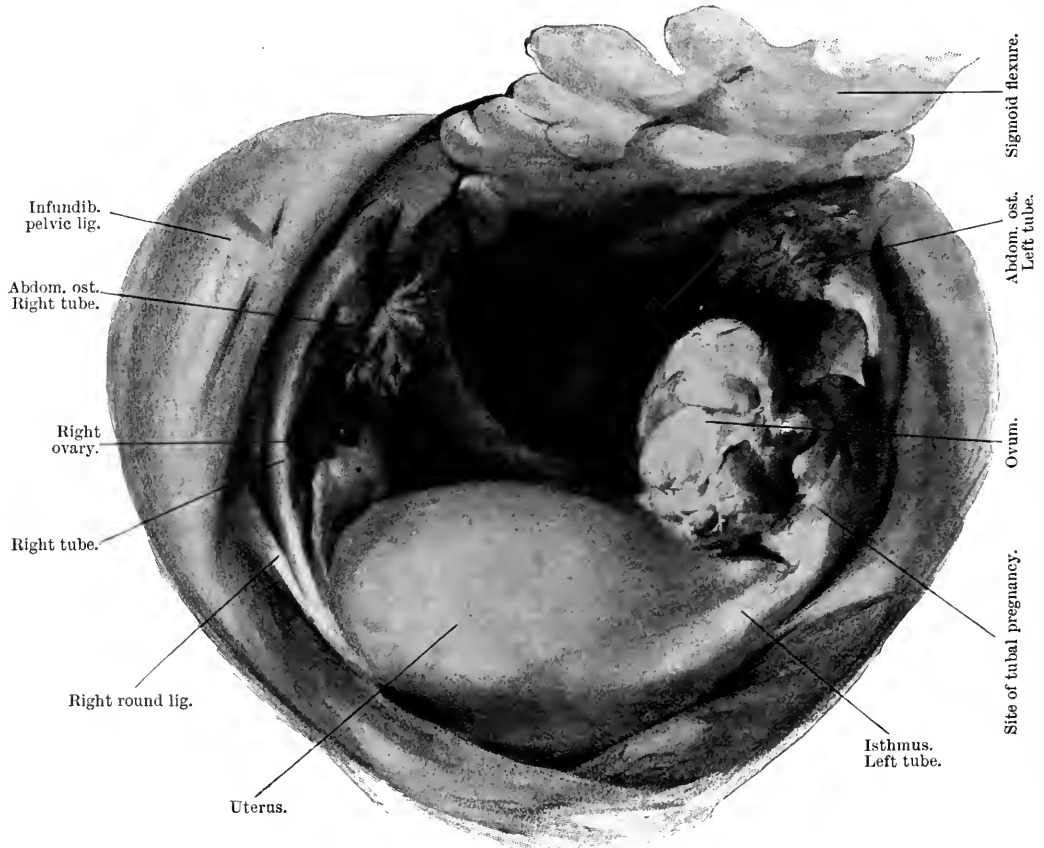


FIG. 215.—Rupture of the tube and haemorrhage into the peritoneal cavity in a case of pregnancy in the isthmal portion of the tube.

(From Bumm.) (A preparation in the Pathological Institute in Basel.)

as a result of tubal abortion. Although a tubal abortion most commonly results in a pelvic haematocoele, yet it may have as a sequel a diffuse intraperitoneal haemorrhage.

In 19 cases of tubal abortion Cullingworth found that 2 resulted in a free effusion of blood into the peritoneum, and 17 in a pelvic haematocoele. Of 34 cases operated upon by Döderlein 27 were cases of tubal abortion with a haematocoele, while 4 were cases of tubal rupture and free intraperitoneal haemorrhage.

Causes other than Ectopic Pregnancy.—The view that cases of haematocoele may owe their origin to the reflux of blood along the Fallopian tubes during menstruation, or in a case of uterine abortion, is difficult to accept. Cases of menstrual haemorrhage from the tubes, however, have been recorded; in that of Landsberg,¹ from a small fistula persisting after an operation for perityphlitis, a clear watery secretion mingled with blood escaped at each menstrual period. The discharge of blood ceased during a subsequent pregnancy but the clear fluid persisted. In Thomson's² case a fistula formed after an operation for a tubal gestation, and some months later haemorrhage occurred from it regularly at the menstrual periods. A sound could be passed into the fistula for 5 cm. down to the left uterine cornu.

The observations of Leopold and von Winckel have demonstrated that at each monthly period the tubes become markedly congested; that bleeding can take place from a healthy tube into the abdominal cavity has not been proved, but that it may occur from a diseased tube seems beyond doubt. Cases of haemorrhage from a tube, the seat of a chronic salpingitis, have been recorded by Fehling, Sanger, and Thorn. Martin has recorded a case of haemorrhage into a hydrosalpinx and its subsequent rupture, with the formation of an intraperitoneal haematocoele; and Gardner has described a haematocoele due to the rupture of a tuberculous Fallopian tube into which bleeding had occurred.

Most of the cases in which internal haemorrhage is supposed to have occurred from the ovary are in reality cases of ovarian pregnancy, but the one recorded by Gabriel³ shows that haemorrhage can occur from a Graafian follicle in the certain absence of an ovarian pregnancy. Bender and Marcille⁴ have described a case due to the rupture of a small haemorrhagic cyst in the left ovary. Both right and left tubes were normal, and histological examination failed to show any signs of pregnancy in the wall of the cyst.

De Rouville has recorded a case due to the rupture of a follicular cyst in an ovary presenting haemo-lymphangiomatous changes, and somewhat similar cases have been published by Marchand, Lockyer, and Tartanson, in which the haemorrhage occurred either from a normal ovary, a corpus luteum, or a diseased ovary. Cases are also on record in which intraperitoneal haemorrhage has occurred from the rupture of a vessel in a myomatous uterus (Wallace).

The rupture of large ovarian cysts or malignant tumours may be the cause of haemorrhage into the peritoneum; thus Gardner has described a case of adenocar-

¹ M. Landsberg, Inaug. Diss., Breslau, 1896, *Zentralbl. f. Gyn.*, 1897, No. 42, 1285.

² H. Thomson, *Zentralbl. f. Gyn.*, 1898, No. 45, 1227.

³ Gabriel, *Zentralbl. f. Gyn.*, 1901, No. 44, 1236.

⁴ Bender and Marcille, *Bull. et Mém. de la Soc. Anat. de Paris*, 1904, s. 6, vi. 569.

cinoma of the ovary, and Fritsch one of sarcoma of the connective tissue of the pelvis, both associated with a haematocele. General diseases, such as purpura and haemophilia,¹ the acute specific fevers, acute yellow atrophy of the liver, phosphorus poisoning, and yellow fever are all said to be occasional causes of haemorrhage into the pelvis; and Sauter has published cases of intraperitoneal haemorrhage in patients the subjects of cardiac, pulmonary, and renal disease, and Freund in a case of double pneumonia. Such a cause as the rupture of a varicose vein in the broad ligament is extremely doubtful, while other possible causes are ruptures of the uterus, or of the vagina, injuries during coitus, or the slipping of ligatures after operations.

In spite of the existence of all these possible causes the fact remains that in the large majority of cases any intraperitoneal extravasation of blood, whether localized or diffuse, is due to an ectopic gestation.

A pelvic haematocele can form without the previous occurrence of peritonitis, but when the peritoneum is or has been inflamed, the blood clots more rapidly, and forms a definite tumour at an earlier date, than in cases in which the serous membrane is quite healthy. Changes in the peritoneum, the result of an old peritonitis, also interfere with the absorption of the effused blood.

Sänger divides haematoceles into the *diffuse and the encysted varieties*. By the diffuse form he means the tumour extending up into the abdominal cavity, the upper boundary of which is formed by coils of adherent intestine, while laterally it is bounded by the walls of the pelvis and the abdomen (Plate IX. B). According to Sänger the blood-clot is traversed by strands of fibrous tissue containing capillary vessels, which may remain after absorption of the blood, and form bundles of new connective tissue.

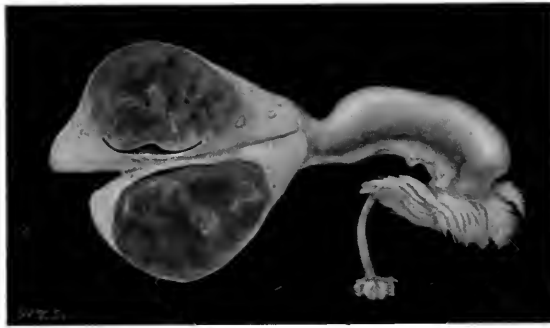
The solitary or encysted haematocele forms a smaller tumour reaching but a short distance above the level of the plane of the pelvic brim, or altogether confined to the true pelvis. It is firmly adherent to surrounding structures, especially to the intestine, and has a true capsule, the outer layers of which consist of a connective-tissue basis, and of organized fibrin. In cases where the capsule is especially well formed, it is often possible to shell out the tumour entire. On microscopical examination the capsule is found to consist of tissue-elements closely resembling connective tissue and unstriated muscle.

In cases of extraperitoneal haemorrhage the collection of blood may be situated in any part of the connective tissue of the pelvis. It may form a tumour lying in the space between vagina, cervix, and bladder, in the broad ligament proper, in the mesosalpinx, or in the cellular tissue at the upper part of the posterior vaginal wall.

¹ E. Winternitz, *Veit's Handbuch der Gynäkologie*, 1899, iii. Pt. 2, 599.

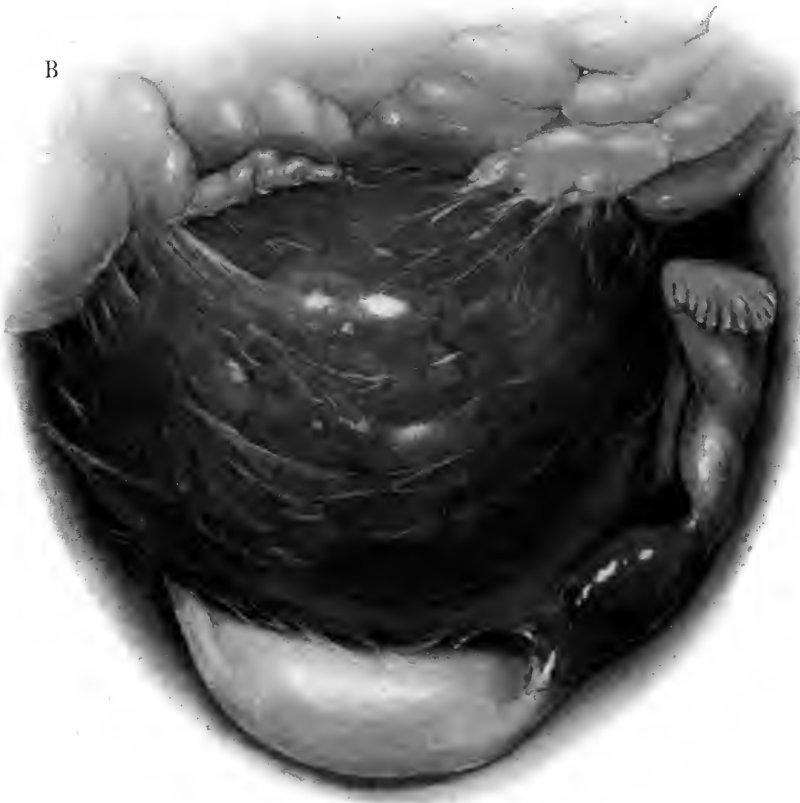
PLATE IX. Vol. I

A



A. An unruptured tubal pregnancy showing intramural implantation of the ovum, which has been converted into a mole. U.C.H. Med. Sch. Museum, No. 690.

B



B. A retrouterine haematocoe secondary to the rupture of a tubal pregnancy in the isthmal portion of the left Fallopian tube.

The composition of the tumour varies with the length of time which has elapsed since the bleeding occurred. In recent cases it consists of fluid blood, in older cases the blood has clotted, and the clot may have become decolorized and organized. At times only the outer part of the tumour is solid, while the central portion is composed of blood, more or less altered, and of a tarry, syrupy consistence. In some cases solidification occurs irregularly throughout the tumour.

The *progress and course* of a case of pelvic haematocele vary to some extent with its causation. When due to a tubal pregnancy it depends whether the case is one of tubal rupture, or tubal abortion, and if of the latter variety, whether complete or incomplete. When an ovum is entirely extruded into the peritoneal cavity, the haemorrhage tends to cease, but if it is completely or partly retained within the tube it sets up repeated haemorrhages, attended with attacks of colicky pain, and the signs of internal bleeding, and followed by symptoms of pelvic peritonitis.

In cases where the bleeding is severe the effusion takes place in a very short time, although at first it may not be possible to detect any tumour. In a few hours or a few days the tumour can be readily felt, and it may ultimately attain the size of a child's head. In such a case, when once formed, it will often not increase any further in size. When, however, the source of the bleeding is a tubal abortion, the growth of the tumour is more gradual, and can be watched from day to day. The mass of blood, at first soft and semi-fluctuating, becomes harder, and of an unequal density, and the sense of fluctuation gradually disappears. In cases where the occurrence of the haematocele has resulted in the death of the ovum, the natural tendency is towards gradual absorption of the effused blood. This holds good even in the case of the largest tumours, provided the mass of blood is safely shut in by adhesions.

In 25 cases observed by Voisin, 15 ended in absorption, and of 75 cases recorded by Champneys,¹ in 35 (*i.e.* 45 per cent) complete recovery took place without any surgical interference. The average duration of these cases is about four months. Braun in 24 cases noted complete absorption in six months. In some cases the tumour diminishes in size very rapidly indeed, but in other cases, when the patients are left without any surgical interference, natural recovery not only takes place very slowly, but is subject to many interruptions. The functions of the pelvic organs may be impaired for many months, with chronic pelvic pain and the physical signs of chronic pelvic peritonitis. In a small proportion of the cases the haematocele undergoes secondary rupture followed by the symptoms of a severe internal haemorrhage.

¹ F. H. Champneys, *Journ. Obstet. and Gyn. Brit. Emp.*, 1902, i. 585.

In other cases suppuration takes place in the collection of blood, and the resulting abscess may burst into the peritoneum, or escape externally through the rectum, vagina, or bladder. Of 27 cases recorded by Voisin, in 6 the abscess burst into the rectum, in 3 into the vagina, and in 4 into the peritoneum. The last accident is very unlikely to occur at the present day, when surgical interference would at once follow the signs of suppuration. Infection of an intraperitoneal haematocoele may take place through the intestine, vagina, or bladder, or sometimes as the result of a posterior colpotomy with imperfect removal of all the blood-clot.

Apart from rupture or infection of the tumour, attacks of peritonitis are likely to occur from time to time.

In cases of extraperitoneal haematoma complete absorption of the blood-clot, and the return of the parts to their normal condition is usually the final result. Of 34 cases observed by Thorn, in only one was any operation necessary, all the others recovered completely. Doran¹ has, however, recorded a case in which he had to remove four pounds of blood-clot from a haematoma in the right broad ligament (into which the right tube opened) which had leaked into the peritoneal cavity. The clot was removed, together with the uterus and appendages, and the patient made a good recovery.

In a patient under my own care, with a history suggesting an ectopic gestation, on abdominal section a tumour about half the size of the foetal head was found occupying the left broad ligament. It was covered by large veins, was of a softish consistence above, and rather harder below. A diagnosis of a broad-ligament haematoma was made, and it was decided to close the abdomen, and incise the tumour by the vagina, if necessary, at a later date. In manipulating the tumour, one of the large veins on the surface was accidentally torn, which necessitated the use of an iodoform gauze plug, brought out of the abdominal wound.

The patient refused any further operation at the time, but returned twenty months later with a small ventral hernia. At an operation undertaken for its cure, the left broad ligament was found to be normal, and the uterus had its normal position and mobility.

ADVANCED TUBAL GESTATION

In a small proportion of cases, a tubal pregnancy continues to develop, either in the tube itself (Fig. 216), or in the tube and in the abdomen (*tubo-abdominal gestation*); or in the tube and in the tissues of the broad ligament (*tubo-ligamentary* or *intraligamentary gestation*).

¹ Alban Doran, *Trans. Obstet. Soc. Lond.*, 1904, xli. 215.

In the first case the pregnancy is most commonly in the ampulla, and the sac is formed partly by the ampullary portion, which is capable of considerable distension and growth, and partly by a taking-up into the sac-wall of the isthmal portion of the tube. The sac may in this way attain a large size, and yet be attached to the uterus by a definite pedicle, formed by the unexpanded proximal part of the tube. Cases have been recorded in which such a tubal pregnancy has, apparently, progressed to full term, but this is very unusual (Chiari,¹ Freund² Whitridge Williams and others). In a few cases, as Werth has shown, the sac is formed by a portion only of the tubal wall, which undergoes distension and growth, forming a swelling, comparable to a paratubal haematocoele. As the sac develops, it acquires

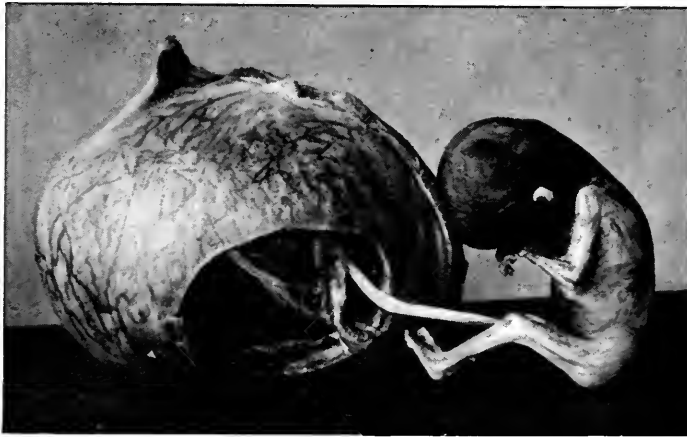


FIG. 216.—The unruptured sac of a tubal pregnancy removed in the fourth month of gestation. (R. Drummond Maxwell.)

adhesions to neighbouring structures, and displaces the uterus, either downwards, or upwards and forwards, or to one side.

Intraligamentary Gestation.—The variety, in which the pregnancy is partly contained within the layers of the broad ligament, is met with most frequently, but even this is not so frequent as it was thought to be by Lawson Tait. As the ovum develops it gradually stretches and erodes the wall of the tube in relation to the cellular tissue of the broad ligament, so that these tissues are opened up and expanded by the growing ovum, which lies in a sac formed in part by the tube, and in part by the broad ligament. The old view that the tube *ruptured into the broad ligament* is no longer held, as, if this occurred, in most of the cases the ovum would be destroyed from the accompanying haemorrhage. When haemorrhage

¹ H. Chiari, *Zeitschr. f. Heilkunde*, 1887, viii. 127.

² Freund, *Beiträge. z. Geb. u. Gyn.*, 1903, vii. 104.

does occur into the cellular tissue, and the ovum ceases to grow, it forms a pelvic haematoma.

If development proceeds, the condition is termed an intraligamentary or broad-ligament gestation, and the pregnancy may continue to full term. The foetus is accommodated in a sac, formed either by the stripping up of the anterior layer of peritoneum of the broad ligament, and then of that covering the anterior and lateral

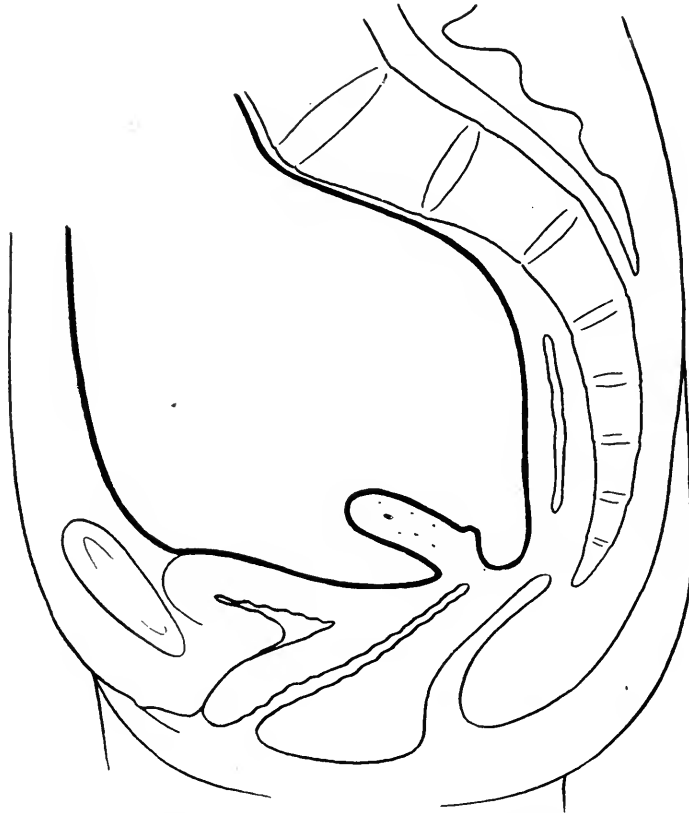


FIG. 217.—A diagram of a sagittal section of the female pelvis a little to the right of the mid line, showing the normal reflection of the peritoneum.

abdominal wall (*anterior subperitoneal pregnancy*) (Fig. 218) or by the elevation of the peritoneum of the posterior layer of the broad ligament, and then of that covering the posterior abdominal wall (from the rectum and the pouch of Douglas as far as the sacral promontory), the so-called *posterior subperitoneal pregnancy* (Fig. 219). In the anterior subperitoneal form the sac in part lies in immediate contact with the muscular layers of the abdominal wall, and often can be laid open by an extra-peritoneal abdominal incision.

As Taylor has pointed out, there are three important points in the relations of an

intraligamentary pregnancy towards full term. In the early months space for the growing pregnancy is obtained by the stripping up of the peritoneum, in the later months by the continued development and extension of the sac. The result of this is that at term, although the pregnancy is entirely outside the peritoneum, it is not much more so than when *in utero*. This applies to both forms, but chiefly to the posterior subperitoneal, where the main tumour may be almost entirely intra-

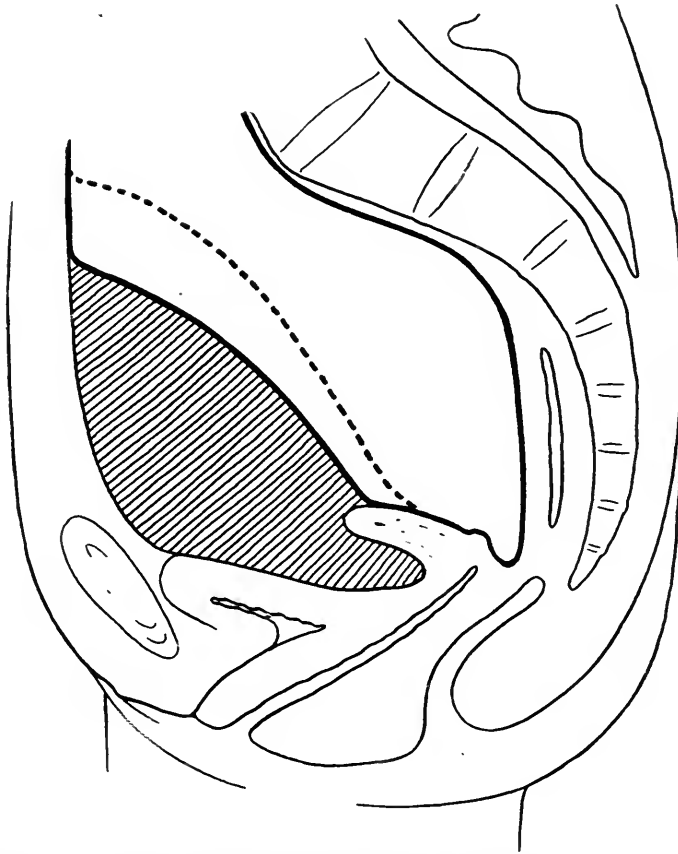


FIG. 218.—A diagram of the manner in which the peritoneum is raised up off the anterior abdominal wall in a case of anterior subperitoneal pregnancy.

peritoneal. This is well illustrated in a case recorded by Fairbairn,¹ in which the patient died, and at the post-mortem examination the sac could be readily drawn out of the abdomen although its base of attachment in the pelvis was very wide, extending from the right broad ligament to the mesocaecum.

The second point is the relation of the placenta to the foetus; in the tubo-abdominal pregnancy the placenta is generally below the foetus, in the intra-

¹ J. S. Fairbairn, *Journ. Obstet. and Gyn. Brit. Emp.*, 1906, x. 599.

ligamentary the foetus is generally below the placenta, at any rate in the early stages of the pregnancy.

Another important anatomical feature in these cases of posterior subperitoneal gestation is their close relation to the rectum. As a result of this, infection of the sac very frequently and very readily occurs, and no doubt it is chiefly this class of case in

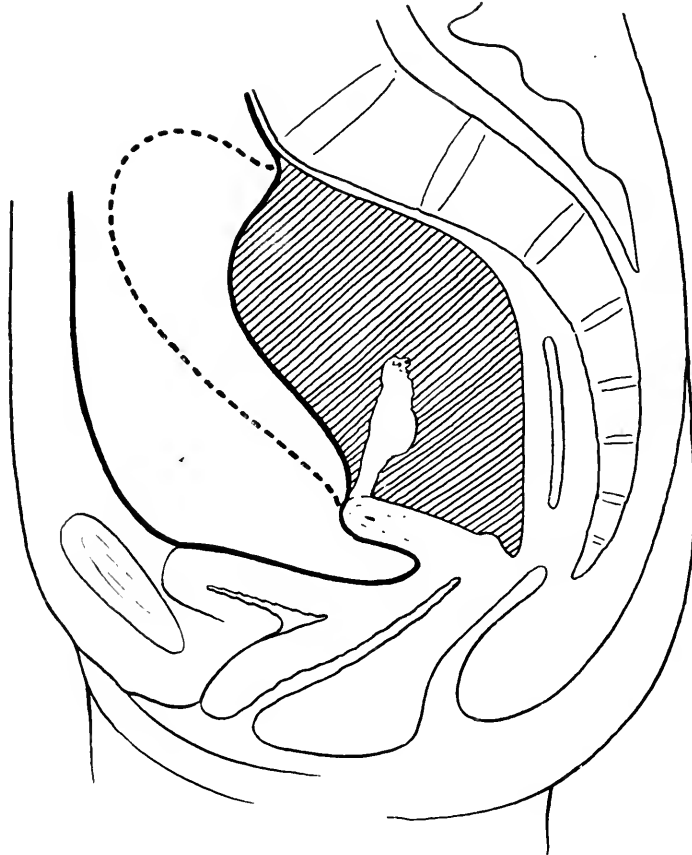


FIG. 219.—A diagram of the manner in which the peritoneum is stripped off the rectum and pelvic floor in a case of posterior subperitoneal pregnancy.

which suppuration takes place, and the remains of the foetus are discharged through the rectum.

The continuance of the subperitoneal or extraperitoneal variety of pregnancy depends mainly upon the exact relation of the placenta to the foetus. If this is situated below, in front, or behind, it undergoes but little displacement in the growth of the foetus; indeed in a case described by Berry Hart¹ the placenta was apparently

¹ Berry Hart, *Guide to Midwifery*, 1912; and "On the Extraperitoneal Form of Extra-uterine Gestation," *Amer. Journ. Obstet.*, 1894, xxix. 577.

normal. If, on the other hand, it is situated, as it most commonly is, above the foetus, then in the growth of the latter it becomes displaced progressively upwards, and detached from its connections with the walls of the sac, haemorrhages occur into its substance, and the foetus perishes. Ultimately the placenta may be converted into a mass of blood-clot and crystals, the villi being distorted, compressed, and surrounded by connective tissue.

When the ovum dies at an early period of the pregnancy, and a pelvic haematoma forms, the result is generally favourable, and the blood ultimately undergoes absorption with the recovery of the patient.

In a true broad-ligament gestation, the ovum lies within it and is covered by the peritoneum of the broad ligament, forming a sessile mass, generally filling up the greater part of the pelvic cavity, and displacing the uterus, which is in close relation to it, to the opposite side of the pelvis. The ovary and its ligament are usually to be found stretched out on the posterior surface of the tumour, but sometimes in the later stages of development the ovary is situated at the summit, or even on the anterior surface of the swelling.

Undoubted cases of broad-ligament gestation are rare, and few of them have been described. Thus it occurred in only 4 instances among 276 cases of tubal pregnancy collated by Küstner, Fehling, Mandl, and Schmidt. Whitridge Williams has observed only one case. A condition often mistaken for this is the so-called *pseudo-ligamentary gestation*, in which the foetus is contained within the ampullary portion of the tube, which becomes secondarily adherent to the posterior surface of the broad ligament, stretched over it like a cap. A careful examination will demonstrate that the sac is only adherent to the posterior surface of the broad ligament, and is not *between its two layers*, and in these cases the ovary is generally in front of the sac, between it and the posterior surface of the broad ligament. No doubt a considerable number of such cases have been improperly described as instances of broad-ligament or intraligamentary gestation.

Tubo-abdominal Gestation.—It was thought by the older writers that if an ovum escaped intact through the abdominal opening of the tube, it could continue to develop in the peritoneal cavity, the placenta acquiring new attachments and new vascular connections to some part of the peritoneum. Leopold's¹ experiments, however, seem to prove that in the early weeks the ovum certainly dies and becomes absorbed. Even after the first few months, if the whole ovum is expelled, this must

¹ Leopold's researches on animals have shown that young foetuses when introduced into the peritoneal cavity are rapidly destroyed, when the peritoneum is healthy, by the action of phagocytes.—Leopold, *Arch. f. Gyn.*, 1881, xviii. 53.

be its fate, but if the placenta remains in the tube, and only the foetus is expelled into the abdominal cavity, no doubt development can continue. This may occur whether the amnion is intact or not, although it is more likely if the amnion is unruptured. Taylor thought that only in these conditions was further growth possible, but more recent observations, such as the case recorded by von Both,¹ show that this is not so. In these cases the placenta either remains wholly within the tube, or a portion of it is extruded, and acquires attachments to the neighbouring structures, such as the rectum, uterus, or pelvic floor. If entirely retained, the opening, whether the natural one or the result of erosion of the tubal wall, tends to close, and finally may become contracted down on to the umbilical cord passing through it.

Although it is possible that in a small number of cases the ovum, when primarily attached near the ampulla, may escape through the dilated abdominal ostium into the peritoneal cavity, yet the opening is more commonly an artificial one, and due to the gradual erosion of the wall of the tube. In this case, if the embryo is to continue its development, it is obvious that the placental site must remain undamaged. If the opening is situated at the placental site, this organ will be so damaged as to cause the death of the foetus. In some cases in which the foetus continues its development in the peritoneal cavity, it is found lying free among the intestines, but in other cases it is surrounded by the amnion, which becoming covered by adhesions, forms a new, secondary sac round the foetus. The cases which have been described, in which the placenta appears to be attached to certain of the viscera in the upper abdomen, are explained by Whitridge Williams as instances of advanced broad-ligament gestation, in which the placenta is situated at the upper part of the sac, and has become adherent to the viscera.

Although a tubo-abdominal pregnancy most commonly results when the ovum is attached near the ampullary end of the tube, yet Bland-Sutton² has described a case of this kind, in which the primary attachment was in the isthmus, and in which the living foetus was found at the operation free among the intestines, the amnion having ruptured near full term. When the pregnancy continues for some months in the interior of the tube, the muscular tissue becomes extremely attenuated and almost disappears, so that the wall may consist of peritoneum only, and the fibrin layer is poorly developed, but the presence of foetal cells, and the changes in the peritoneum which already have been described, may be demonstrated. When the foetus has been dead some time inflammatory changes with dense adhesions may be found round the tube or the gestation-sac. A few cases have been recorded

¹ von Both, *Monatsschr. f. Geb. u. Gyn.*, 1899, ix. 782.

² Bland-Sutton, *Trans. Obstet. Soc. Lond.*, 1898, xl. 308.

in which the ovum had apparently had a primary attachment to the ovarian fimbria, and had developed in this position.

An ectopic gestation attached to the ovarian fimbria is of interest because it affords an explanation of at any rate some so-called cases of primary abdominal gestation.

PRIMARY ABDOMINAL GESTATION

At one time this variety was thought to occur not infrequently, but at the present time its occurrence is regarded as not proven, in most of the cases described as of this kind.

Bland-Sutton denies that it occurs, and draws attention to the interesting case recorded by Leopold¹ in 1896. A woman near the mid-term of her pregnancy injured herself by falling down stairs. When she arrived at what she thought to be full term, an extra-uterine gestation was diagnosed, and coeliotomy performed. A foetus of about the fourth month of gestation, enclosed in a thin amniotic sac, was found in the abdomen, and its umbilical cord passed through a rent in the back of the uterus. The uterus and placenta were removed subsequently with success. Bland-Sutton has shown that the cases reported as instances of extra-uterine gestation in cats, bitches, and rabbits are really examples of this kind of utero-abdominal gestation. In 1891 he called attention to this condition, and pointed out that many of the foetuses are too large to pass through the maternal passages, and that the uterus, contracting violently, ruptures, and the foetus is discharged into the abdomen. After the foetus escapes the uterus rapidly contracts, so that the slit, which allowed a full-sized foetus to escape, becomes reduced to a very small opening. The majority of these accidents terminate fatally, but in rare cases the mother survives, and the foetuses in their sacs may adhere to the omentum, or to the intestine, or they may remain free in the abdomen. The amniotic fluid is absorbed, and the sac, thickened by a deposit of lymph, contracts down on to the foetus.

Foetuses found in the bellies of cats and bitches are not, according to Bland-Sutton, the result of primary abdominal pregnancy, but are in reality examples of such a utero-abdominal pregnancy (Fig. 220). Blair Bell's case, which he believed to be a primary abdominal pregnancy in the rabbit, has already been alluded to (see p. 427).

It is obvious how easily an ovum attached primarily to the ovarian fimbria may be mistaken for an abdominal pregnancy. In its development it quickly outgrows its site of attachment, and acquires secondary attachments to neighbouring viscera,

¹ Leopold, *Arch. f. Gyn.*, 1896, lii. 376.

and in this way its original site of attachment may well become obscured. Both the cases described by Schleghtendal and Walker¹ as instances of primary abdominal pregnancy are probably of this nature.

The presence of small nodules of decidua scattered over the peritoneum, especially in Douglas' pouch, shows that it is possible for a genetic reaction to take place

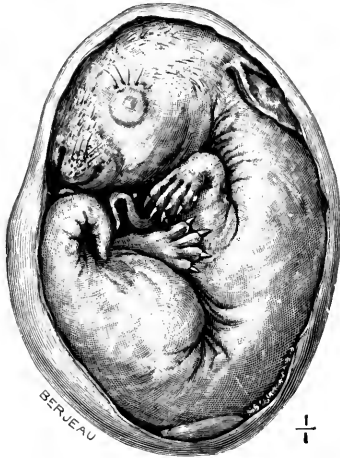


FIG. 220.—An embryo rabbit found with others free in the belly of a doe. (Museum of the Royal College of Surgeons.)

in tissues outside the genital tract. The further fact that the ovum can become implanted, and grow in the tissue of the ovary in the absence of any decidual reaction, is an argument in favour of the possible occurrence of a primary abdominal foetation. We now recognize that the formation of decidua is not essential to the embedding of the young ovum, but the fact that the connective-tissue cells of the subperitoneal tissue can undergo such development would seem to increase the likelihood of this membrane being able to give attachment to, and furnish the nourishment necessary for, the early ovum.

If a true primary abdominal pregnancy is to be demonstrated, it must be in a case in which the ovum is found at such an early stage that if it had commenced its development in the tube, and been secondarily expelled into the peritoneum, the tube, when carefully examined microscopically, must still show some traces of its having been the original seat of the pregnancy. A microscopical examination is necessary because, as Bland-Sutton and Cullingworth have shown, to naked-eye examination a few hours after the expulsion of an early ovum the tube may have resumed its normal size and appearance. The cases which usually are brought forward as possible examples of primary abdominal pregnancy, are those of Galabin² (Fig. 221), Witthauer,³ Hirst and Knipe,⁴ and Gröné.⁵ No certain conclusions can be drawn from any case in which the pregnancy has advanced beyond the very early stages.

In Galabin's case the foetus corresponded in its development to that of ten weeks, and no microscopical examination of the Fallopian tubes appears to have been carried

¹ For a good criticism of the cases of so-called primary abdominal gestation recorded up to that date see Alban Doran, *Trans. Obstet. Soc. Lond.*, 1893, xxxv. 222.

² Galabin, *Trans. Obstet. Soc. Lond.*, 1896, xxxviii. 88.

³ Witthauer, *Zentralbl. f. Gyn.*, 1903, No. 5, 136.

⁴ Hirst and Knipe, *Surgery, Gynecology, and Obstetrics*, 1908, vii. 456.

⁵ O. Gröné, *Zentralbl. f. Gyn.*, 1909, No. 2, 45.

out. It has now been clearly shown that within a very short time of a tubal abortion the tube may, to macroscopical examination, appear perfectly normal. That the case was one of primary abdominal foetation, and not, as the committee who reported upon it suggested as possible, one of very early tubal abortion, is impossible to prove. It is, however, doubtful if, in even a very early tubal abortion, the ovum would not, in almost every instance, be too damaged to continue to develop in such a relatively unfavourable environment as the peritoneal cavity. It is interesting

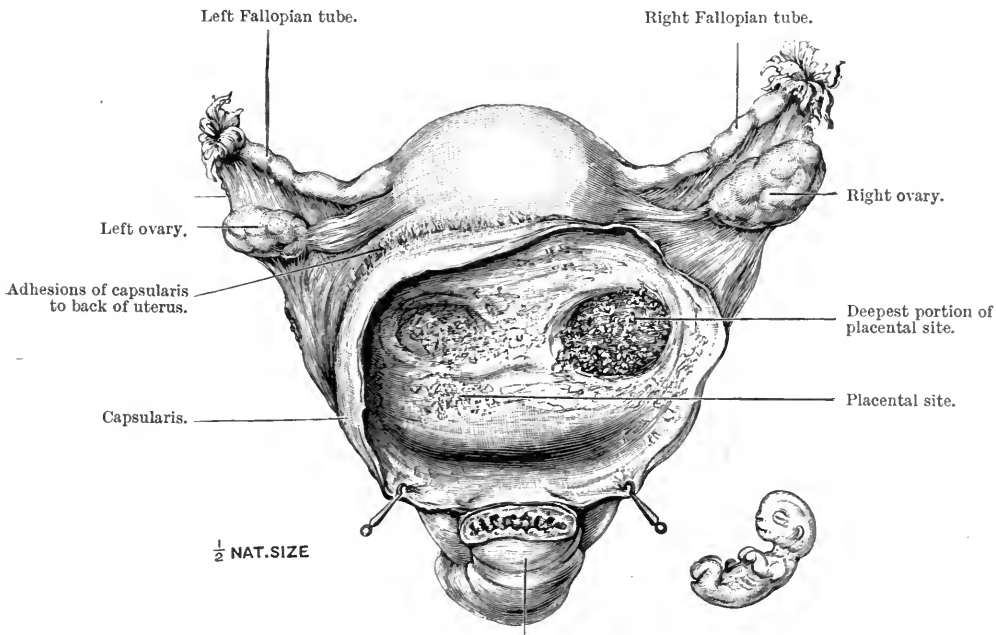


FIG. 221.—Case of primary abdominal foetation. (Galabin.)

to note that in this case the site of the placenta was low down on the posterior surface of the broad ligament, as it was also in the case recorded by Hirst and Knipe.

In Witthauer's case, the evidence is much less satisfactory. Here a small haematoma containing chorionic villi, but no other trace of an ovum, was found encapsuled in the omentum, and the tube of the same side (the right) was said to be normal on microscopical examination, but a complete series of sections was not made. The right ovary was converted into a cystic tumour, and the left appendages are described as normal.

In Hirst and Knipe's case a spherical tumour with a small orifice on its surface was attached to the posterior surface of the broad ligament just above, and to the outer side of the utero-sacral ligament. This showed a connective-tissue

capsule infiltrated with blood, the subperitoneal connective-tissue cells were hypertrophied, and somewhat resembled decidual cells, and through the orifice chorionic villi protruded, surrounded by clotted blood. The tubes, ovaries, uterus, and the remainder of the broad ligaments were perfectly normal.

In Gröné's case about a pint of free blood was found in the peritoneal cavity. Neither the Fallopian tubes nor ovaries showed any sign of gestation or rupture. The source of the bleeding was found to be a raw surface about the size of a shilling, situated on the peritoneum, almost at the pelvic brim, between the caecum externally and the round ligament internally. The surface was free from deep attachments and, with a small piece of the surrounding peritoneum, was excised. The uterus and appendages appeared normal. Two small bodies, found in Douglas' pouch, one as large as a walnut, and the other a little smaller, were removed, together with the right tube. Microscopical examination of the tube showed it to be entirely free from any signs of inflammation or of gestation. Gröné maintains that this is a true example of primary abdominal gestation, because no other implantation than the raw surface could be found on naked-eye examination of the right ovary and left appendages, and on microscopical investigation of serial sections of the left tube. That the peritoneal implantation was primary he believes, because the sections of the raw surface showed a very definite layer corresponding in its structure to Nitabuch's fibrin layer; inside this layer were undoubted chorionic villi, and in immediate contact with these villi, cells resembling those of Langhans' layer and syncytial cells. He considers that this case fulfils the conditions laid down by Veit as necessary for the proof of a primary abdominal pregnancy, namely that a living ovum must be found in the peritoneal cavity, with its placenta in functional union with the peritoneum, without any participation of the tube or ovary.

It is certainly difficult to deny the possibility of the occurrence of a primary abdominal pregnancy in the light of this carefully described and fully recorded case.

Tubo-ovarian Pregnancy.—Tubo-ovarian pregnancy is one in which the sac-wall is formed partly by the tube and partly by the ovary. The term strictly should be confined to those very rare cases in which pregnancy occurs in a tube communicating with a distended Graafian follicle, or in a true tubo-ovarian cyst. A few cases of this kind have been reported, but a probable explanation of some of them may be a secondary attachment of the pregnant tube to the ovary, or pregnancy occurring in a tube primarily adherent to the ovary, or a peritubal haematocele which has acquired secondary adhesions to the ovary. One of the most noteworthy cases has been recorded by Paltauf,¹ in which two ovarian cysts communicated not only with

¹ A. Paltauf, *Arch. f. Gyn.*, 1887, xxx. 456.

one another, but also with the two tubes, and the larger of the two cysts contained a mass of blood-clot adherent to its walls, which apparently was the implantation-site of an ovum.

TUBO-UTERINE OR INTERSTITIAL PREGNANCY

The ovum in an interstitial pregnancy is situated in the portion of the tube passing through the uterine wall (Fig. 222). Some writers distinguish a *utero-tubal* form in which a portion of the isthmal part of the tube is drawn up for the

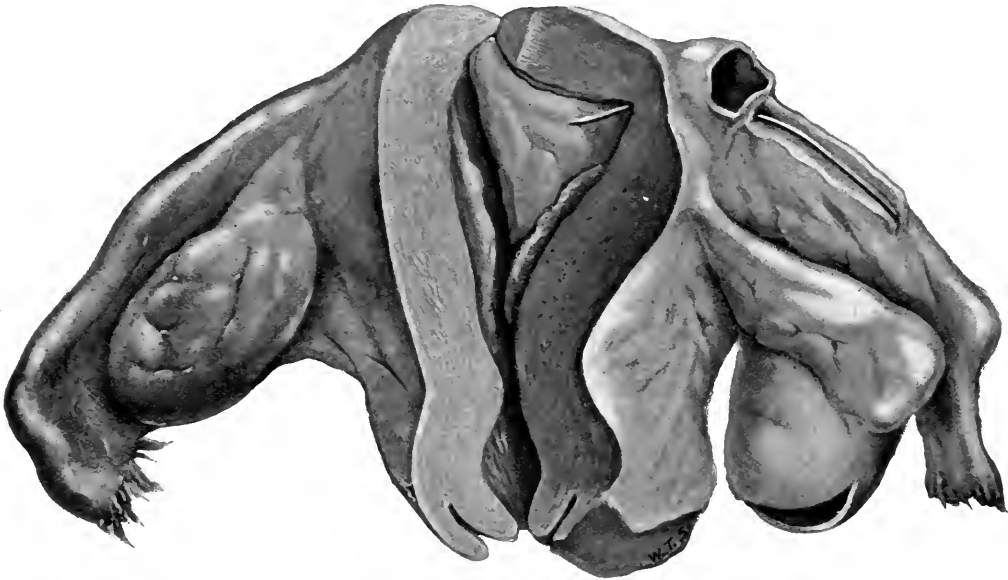


FIG. 222.—The uterus and appendages from a case of ruptured interstitial tubal pregnancy. (U.C.H. Med. Sch. Museum, No. 717.)

reception of the enlarging ovum, and a *tubo-uterine* form in which the ovum encroaches on the uterine cavity. It is difficult to distinguish with certainty the first from an isthmal pregnancy involving the uterus, and the second from an intra-uterine pregnancy situated in the tubal angle. The presence of a well-marked decidua is always in favour of the ovum having been primarily attached in the uterus.

The condition is certainly a very rare one. Martin only met with one among 77 cases of tubal gestation treated by operation, and Werth did not see a case among 120 cases of ectopic gestation. The causation of an interstitial gestation does not differ from that in any other part of the tube, but such a case as that recorded by Lesse¹ is particularly interesting. He removed the right tube for a tubal pregnancy.

¹ Lesse, *Zentralbl. f. Gyn.*, 1905, No. 18, 554.

A year later pregnancy occurred in the stump, the sac involving the cornu of the uterus and rupturing at the sixth month. Lesse operated and the patient recovered.

Owing to the few cases on record, we do not know much of the microscopic details, but the general appearances appear to resemble very closely those seen in other forms of tubal gestation. It is interesting to note that, as Werth points out, the older writers recognized that the sac lay in immediate contact with the uterine muscle, and that the decidua was absent. The macroscopical appearances of this condition are very typical and uniform. Owing to the fact that the tubal lumen lies closer to the posterior wall of the uterus than to the anterior, the sac usually develops upwards and backwards, and forms a more or less oval projection at the corresponding cornu of the uterus. The fundus is generally displaced downwards and to the opposite side, and the appendages on the sound side are attached at a lower level than those on the affected side (Ruge's sign). In the early stages of the pregnancy a definite localized tumour is found at the uterine end of the tube, upon the summit of which the tube is inserted.

The tubal lumen is generally obliterated, but in some of the early cases it can still be recognized owing to the fact that the early ovum is embedded outside the lumen. In other cases a portion of the uterine end opening into the sac, can be distinguished. As the ovum develops, the wall of the sac remote from the uterus becomes gradually thinned, and finally may consist only of peritoneum. As the sac increases in size the attachments of the round and ovarian ligaments become separated from one another, the former being attached to the *external surface* anteriorly and the latter to the posterior aspect. The Fallopian tube at first lies to the outer side of the sac, but if the latter develops to any extent, it becomes displaced downwards and outwards below it. Owing to the more frequent attachment of the ovum in the middle or outer area of the interstitial portion of the tube, the two cavities, that of the sac and that of the uterus, generally remain definitely separated from one another, but there may be only a thin septum between them, and in exceptional cases a wide communication with the uterus is present (Fig. 222).

In a case recorded by Braxton Hicks¹ the foetus of about five months and a half was expelled from the uterus, and three days later the patient died from internal haemorrhage. The sac containing the placenta was situated at the right angle of the fundus, and communicated by a large opening with the uterine cavity. The formation of this opening is no doubt due to gradual destruction and thinning of the septum. That an interstitial pregnancy can gradually make its way into the uterine cavity, and there continue to develop as an intra-uterine pregnancy, is

¹ Braxton Hicks, *Trans. Obstet. Soc. Lond.*, 1867, ix. 57.

extremely doubtful, although some authors have recorded cases which they thought were of this nature.

An interstitial pregnancy, as we have seen, is rare, and is likely to be mistaken both for an isthmal and a cornual pregnancy. An isthmal pregnancy can be distinguished by the attachment of the round ligament to the inner side of the sac, while in the interstitial and cornual pregnancies it is attached outside the sac. It is only in that variety of cornual pregnancy in which the undeveloped horn is attached by a broad base high up on the side of the uterus, that any confusion is likely to arise. An interesting feature of the interstitial variety is the relatively marked hypertrophy of the uterus which accompanies it, and which is much more evident than is usual in cases of isthmal pregnancy. In making a diagnosis between these two conditions, stress is to be laid on the characteristic displacement of the fundus of the uterus, and the difference in the level of the attachment of the appendages, to which attention has already been called. These two points are well illustrated in the case represented in Figure 223 described by Alban Doran.¹ A classical example of this kind of pregnancy is illustrated in Figure 224 which was published by Braxton Hicks² in 1860.



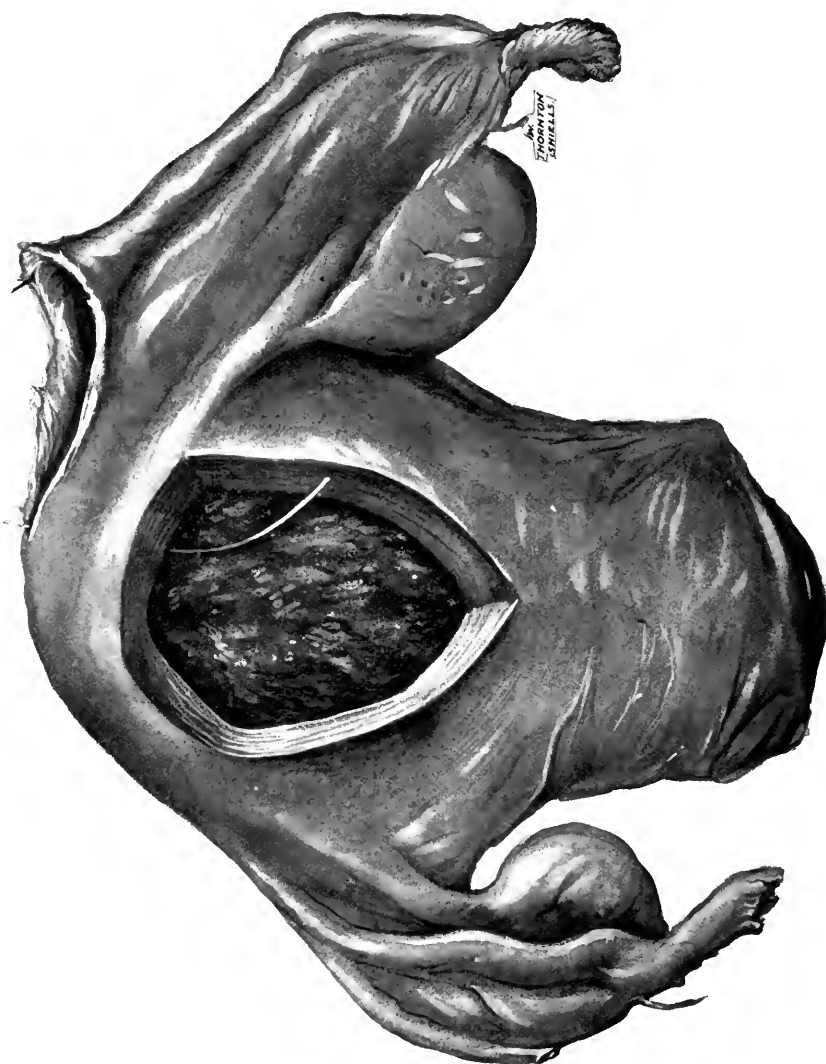
FIG. 223.—Tubo-uterine or interstitial gestation.
(From a specimen in the Museum of Guy's Hospital.)

Rupture of an interstitial pregnancy usually occurs through the posterior wall of the sac, *at a somewhat later date than that of a tubal pregnancy*. Of 32 cases collected by Werth, in 18 the sac ruptured between the first and the third month, and in 14 between the third and the sixth month.

It may, however, rupture at quite an early stage of the pregnancy, and in these cases, the patient usually dies rapidly from haemorrhage. The rupture may take place in one of two directions—into the abdominal cavity or into the uterus—

¹ Alban Doran, *Trans. Obstet. Soc. Lond.*, 1882, xxiv. 227.

² Braxton Hicks, *Guy's Hospital Reports*, 1860, Series 3, vi. 275.



A

B

FIG. 224.—A, Tubo-uterine or interstitial pregnancy. The ruptured sac is situated at the right side of the fundus of the uterus. The patient died twelve hours after the onset of the symptoms, the abdominal cavity containing nearly six pounds of clot and five pints of blood-stained fluid. B, The foetus from the same case. (Royal College of Surgeons Museum, Nos. 463, 464.)

and in the latter case, it may be discharged like an ordinary uterine pregnancy. In a few cases the sac has been removed before rupture occurred.

Intraperitoneal rupture of the sac is much more rapidly fatal than in a tubal pregnancy, and the explanation for this is found in the greater thickness and vascularity of the walls, and the extension of the tear into the uterine muscle.

In a small percentage of the cases the pregnancy may be terminated by the death of the ovum, and its absorption, or conversion into a mole, and no doubt from time to time such a pregnancy ruptures, and yet the patient survives.

True cases of interstitial pregnancy, in which the pregnancy has persisted beyond the sixth month, are almost unknown, but a case has been recorded by Windisch,¹ in which the pregnancy persisted without any distress for two months beyond full term.

PREGNANCY IN THE ACCESSORY HORN OF A UTERUS BICORNIS

There are three forms of double uterus of interest to the obstetrician—the *uterus bicornis bicollis*, the *uterus bicornis unicollis*, and the *uterus septus bilocularis*. The true double uterus or *uterus duplex*, with one possible exception, has been met with only in monsters. The well-developed uterus bicornis bicollis or bicornis unicollis is not so uncommon, and it has been shown that pregnancy may occur in such a uterus, go on to full term, and labour may take place normally. There is, however, a condition of much greater importance and interest than any of those, and that is the occurrence of pregnancy in the more or less rudimentary horn of a uterus bicornis unicollis. Two varieties may be distinguished: in the first the muscle and vessels are well developed, and the pregnancy may continue to the later months, or even to full term; and in the second the muscle and vessels are less well developed, and rupture generally occurs in or before the fourth month of the pregnancy. In some cases the horn is so rudimentary that it is completely solid, but more commonly it contains a cavity, although the band of tissue connecting it to the uterus in the majority of cases is solid. Thus in 82 cases collected by Kehrer, it was solid in 57, or 78 per cent; it contained a lumen in 11, or 15 per cent; and in 5, or 6.5 per cent, the lumen had undergone secondary obliteration. The absence of any communication between the cavity of the horn and that of the cervix of the uterus, and so with the vagina, raises the problem how the spermatozoa find their way into the accessory horn. It is obvious that in many of the cases, external migration of the spermatozoa across the peritoneal cavity must take place; and in those cases in which the corpus luteum is in the

¹ Windisch, *Zentralbl. f. Gyn.*, 1909, No. 19, 655.

opposite ovary, external migration of the ovum must occur, either before or after fertilization. In many of the cases pregnancy had taken place without any incident in the normal horn before it occurred in the accessory horn. A few cases have been recorded in which the accessory horn has given rise to dystocia, due to the retention within it of a lithopaedion, or to its impaction in the pelvis (Müller). Cases have also been recorded of concomitant pregnancy in the normal and rudimentary horns.

Pregnancy in a rudimentary horn of a uterus bicornis is not an uncommon event,

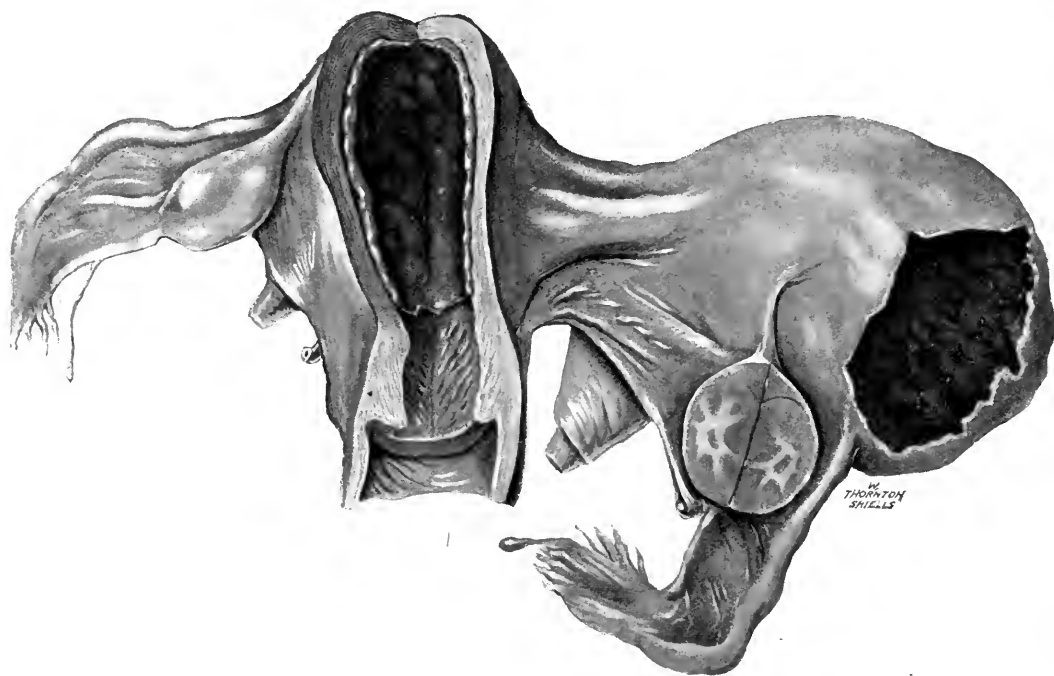


FIG. 225.—A bicornute uterus with a ruptured pregnant right horn; the pregnancy is of about $3\frac{1}{2}$ months' duration. A decidua has formed in the uterus. (U.C.H. Med. Sch. Museum, No. 716.)

and in a recent paper on this subject Beckmann states that the number of cases on record is about 146. In most cases the mucosa of the rudimentary horn is poorly developed, and no decidua is formed. The wall undergoes an hypertrophy dependent in its amount upon the degree of development of the muscular tissue. As the horn enlarges with the growth of the ovum, most of the muscular tissue is found at its base near its attachment, and the upper part consists mainly of connective tissue. As it develops further, it grows mainly at the expense of its inner and upper wall, so that the attachment of the appendages undergoes some displacement downwards away from its summit (Fig. 225). The origin of the Fallopian tube and that of the ovarian ligament remain close together, but they may be separated by some little distance

from the round ligament, which may take origin from the anterior surface of the horn near its outer extremity. This ligament usually becomes considerably thickened and hypertrophied. The relation of the round ligament to the gestation-sac is of importance in the distinction between a tubal pregnancy and a cornual pregnancy. In a tubal pregnancy the round ligament is attached on the inner side of the gestation-sac, and in a cornual pregnancy on the outer side of the gestation-sac. The pregnant horn may be attached in a sessile manner by a broad pedicle extending almost to the fundus of the uterus, but more frequently the pedicle is narrow and long, and when this is the case, the mobility of the horn may be considerable.

Menstruation ceases in the developed horn of the uterus; it becomes hypertrophied, and a decidua is formed which is usually expelled on the death of the foetus, after which the menstrual periods may return. Rupture of the sac occurs most commonly on its upper and inner wall, not at the apex, and the site of rupture undergoes a gradual process of thinning (Fig. 225). This is due partly to the action of the cells of the trophoblast, whose eroding powers are unchecked by the presence of decidua, and whose action on the muscle-fibres is similar to that seen in cases of tubal pregnancy;¹ in part possibly to muscular contractions, and partly to the increase of tension accompanying the growth of the ovum within the sac. Not infrequently the actual burst is the result of some mental or physical shock. When rupture occurs, the foetus generally dies from interference with the placental circulation, but sometimes it survives and continues to develop for a time in the abdomen, as in two of Beckmann's cases.²

The haemorrhage accompanying the rupture is not always severe, a fact possibly due to the comparative avascularity of the sac-wall at the common site of rupture, or because of the gradual giving way of the tissues by a process of erosion.

The three possible modes of termination of such a pregnancy are (1) its cessation from death of the ovum in the early weeks, (2) rupture of the sac, or (3) the continuance of the pregnancy to full term. Of 121 cases collated by Cohn, rupture occurred in 51, or 44·5 per cent, and in 33 of these, in or before the fourth month. If the pregnancy goes on to full term, as occurred in 11 of the 146 cases collected by Beckmann (Fig. 227), a false labour takes place, the foetus dies, and is retained. No proved cases have been recorded in which it has been expelled through the uterine cavity. Ultimately the foetus becomes macerated, or its soft parts are

¹ Lockyer, *Trans. Obstet. Soc. Lond.*, 1906, x, 583.

² Beckmann, *Zeitschr. f. Geb. u. Gyn.*, 1911, lxviii. Pt. 3, 600.

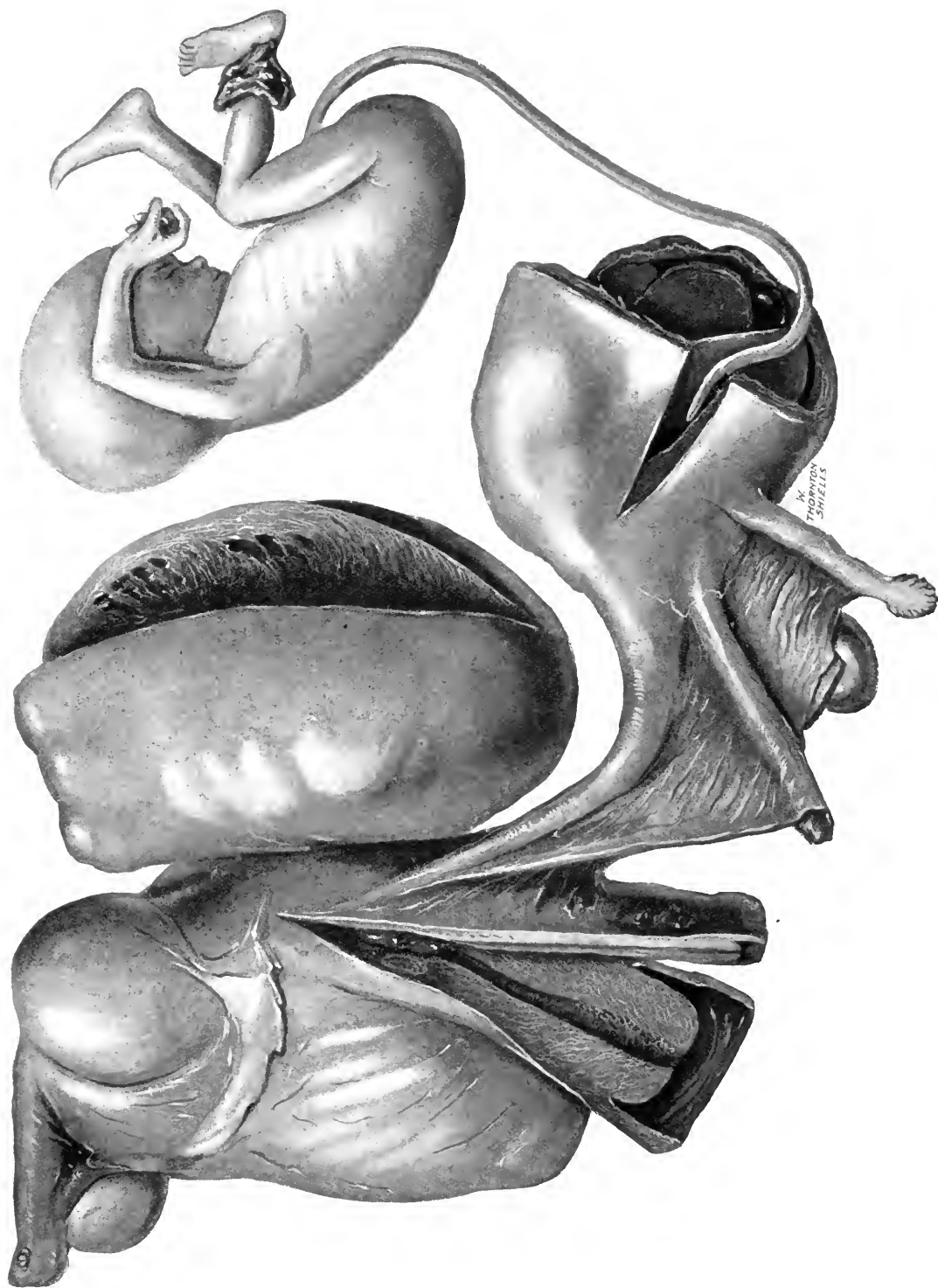


FIG. 226.—A bicornuate uterus with rupture of the pregnant left horn, the right horn containing numerous interstitial and subserous fibromyomata.
(U.C.H. Med. Sch. Museum, No. 715.)

absorbed, and the bones alone remain, or it becomes converted into one or other of the forms of lithopaedion. In some cases infection occurs, and an abscess forms, which may discharge by the bowel. As in other forms of ectopic pregnancy the foetus is often malformed from want of space in the sac.

If the possibility of the occurrence of a cornual pregnancy is borne in mind, its *diagnosis* may not be difficult. If the foetus is dead the tumour is most likely to be



FIG. 227.—Gestation-sac from a case of full-term pregnancy in the rudimentary horn of a uterus bicornis.
(J. H. Targett.)

- | | |
|---|--|
| S, Summit of sac. | O, Right ovary. |
| C, Umbilical cord protruding from an incision in the sac. | R, Right round ligament. |
| T, Right Fallopian tube. | X, Site of right uterine vessels where they reach the wall of the sac. |

mistaken for a uterus bicornis, a myoma, or an inflammatory mass. If still alive the physical signs will resemble those of an abnormally situated gravid uterus. At first the pregnant cornu will be to one side of the middle line, but as the pregnancy proceeds it will assume a more central position with the non-pregnant cornu displaced downwards and to the opposite side. The latter may also present some of the signs of pregnancy, such as enlargement and softening of the cervix.

The absence of much pain or tenderness, the mobility of the tumour when the pedicle is a narrow one, and changes in its consistence¹ may help in the diagnosis; but in many cases even after removal, the exact nature of the pregnancy is often difficult to determine. The ease or possibility of making a correct diagnosis before operation, depends a great deal upon the thickness, length, and structure of the pedicle of the horn, the ease with which it can be palpated, and whether the foetus is dead or alive. Occasionally the round ligament, passing upwards and outwards to the upper part of the sac, can be detected, and helps in the diagnosis. If a cast of the uterine decidua is expelled from the non-pregnant horn, its pointed cylindrical shape may assist in the recognition of this form of pregnancy (Fig. 225). In a number of cases a correct diagnosis has been made before operation, and an instance of this kind was recorded by Sanger so long ago as 1882. If the diagnosis of the condition is made before rupture takes place, surgical interference should be carried out at once, and at the time of rupture it is of course necessary to save the patient's life.

If possible the sac alone should be extirpated. If this is impossible, then the uterus should be removed by subtotal or total hysterectomy; if the sac is suppurating, it may be attached to the sides of the abdominal wound, and then laid open and drained or plugged with gauze. The prognosis after operation is relatively good. Of 36 cases with clear histories collected by Beckmann, 2 died from rupture, 10 recovered after rupture, while 24 were operated upon before rupture occurred with no deaths, a mortality rate of 5.5 per cent. In 5 of the cases collected by Beckmann the patients bore children in the normal cornu after recovering from the operation, and Doran² has also recorded 2 cases of this kind.

There were only 2 deaths among 54 cases collected by Werth in 1904. In the case recorded by von Ott³ a living child was removed, which lived for six hours, measuring 58 cm. in length and weighing 2400 grammes.

SIMULTANEOUS INTRA-UTERINE AND EXTRA-UTERINE PREGNANCY

The occurrence of a multiple pregnancy, in which one ovum is situated within the uterus and the other external to its cavity, is a matter of great importance, not only because of the difficulties attending the diagnosis, but also because of the dangers to the mother of this abnormality. Neugebauer⁴ in 1907 collected 171 cases, and his monograph forms a very notable addition to our knowledge of this condition. In 4 of

¹ M. Cohn, *Rev. de Gyn. et de Chir. Abd.*, 1909, xiii. 1.

² Doran, *Journ. Obst. and Gyn. Brit. Emp.*, 1906, ix. 448.

³ von Ott, quoted by Serejnikoff, *Monatsschr. f. Geb. u. Gyn.*, 1898, viii. 232.

⁴ Fr. v. Neugebauer, *Zur Lehre von der Zwillingsschwangerschaft mit heterotopem Sitz der Fruchte*, Leipzig, 1907.

his cases there were three ova present, in 3 of these the twins were found *in utero*, and in 1 case they were extra-uterine. Nine of the cases, or 5.3 per cent, were examples of interstitial gestation, and in 6 the ectopic pregnancy was said to be in the ovary. When a tubal and a uterine pregnancy occur concurrently, the complication may be recognized in the early months, and terminated by operation, or by the occurrence of tubal rupture or tubal abortion, or the two pregnancies may progress to full term. A third possibility is that in which an intra-uterine gestation is complicated by the presence in the abdomen of an old, sequestered, extra-uterine foetus.

The interruption to the course of the tubal pregnancy may take place either early or late. In some cases the intra-uterine pregnancy is so early at the time of the removal or rupture of the tube that it is not recognized. The true condition is revealed in the subsequent course of the case, or is discovered at the time of operation (Boyd,¹ Zinke²). In some cases, on the other hand, the tubal mole is not recognized until after abortion of the uterine contents has taken place. The cases of concurrent tubal and uterine pregnancy in which the tubal pregnancy is represented by a mole are but rarely diagnosed. A common termination of such a combined pregnancy is that the tube aborts or ruptures in the early weeks of the pregnancy, and this is followed by the expulsion of the uterine contents. The nearer the site of implantation of the ovum in the tube is to the uterus, the more likely is uterine abortion to occur. When the gravid tube is removed without undue delay, in a fair proportion of the cases the uterus will tolerate the interference, and the intra-uterine pregnancy proceed safely to term. In Boyd's case the uterine pregnancy not only went on to term, but the patient subsequently again became pregnant. Walther³ has reported a case of combined pregnancy in which the left Fallopian tube contained a mole, and was successfully removed. Three days later the patient aborted, and the uterus was found to be an example of uterus bilocularis septus, the right horn containing a placenta and the left a well-developed decidua.

The cases in which the uterine and tubal pregnancies develop concurrently to the later months of pregnancy form a most dangerous condition. The difficulty of correctly diagnosing such a combined pregnancy is shown by the fact that in only 7 of the 171 cases collected by Neugebauer was a correct diagnosis made and confirmed by operation; in 8 cases, however, it was suspected, and in 21 it was found during or soon after delivery. In 24 instances the correct solution of the case was only arrived at by a post-mortem examination. Of 154 cases, 54, or 34.6 per cent, of the intra-

¹ Boyd, *Brit. Med. Journ.*, 1901, ii. 962.

² E. G. Zinke, *Amer. Journ. Obstet.*, 1902, xlv. 623.

³ H. Walther, *Zeitschr. f. Geburts. u. Gyn.*, 1895, xxxiii. 389.

uterine children reached the full term, and of these 49, or 31·3 per cent, were born alive. Of the extra-uterine children on the other hand only 32, or 21·4 per cent, reached full term, and of these only 4, or 2·7 per cent, were delivered alive. A remarkable fact is that in no less than 29 cases both children reached full term, while in the case of a triplet pregnancy, in which one of the children was extra-uterine and two intra-uterine, this also occurred.

The importance of treating these cases by abdominal section is seen by the fact that of 87 women operated upon in this way 70, or 80 per cent, recovered; while of 67 not treated by operation, no less than 31 died. Among 83 cases in which abdominal section was performed during pregnancy, or soon after delivery, 17 of the mothers died, *i.e.* a death-rate of 19 per cent. The frequency with which both foetuses reach full term may be due, as suggested by Neugebauer, to the fact that the normal pregnancy with its increased pelvic circulation favours the development of the extra-uterine foetus. Chrobak¹ extracted by abdominal section a living extra-uterine child five days after the birth of a full-term child, and Wilson² did the same thing twenty-six days after the delivery of a living child from the uterus. The danger of this condition is, however, so great that the life of the mother should alone be considered. Among 152 of Neugebauer's cases, 47 of the mothers died, or a mortality rate of 30·6 per cent. Nineteen died of internal haemorrhage without operation, 9 in spite of operation. Five died of septic peritonitis, following operation, 4 died of sepsis following the birth of the intra-uterine child, and 3 of pyaemia from the retention of the extra-uterine foetus.

The presence of a lithopaedion, especially if it is situated in the pelvic cavity, may constitute a serious obstruction to the birth of an intra-uterine foetus. In Franklin's³ case the head of the extra-uterine foetus was situated in the pelvic cavity, and obstructed delivery. Porro's operation was performed and a living foetus delivered; the extra-uterine foetus, however, was dead, and severe bleeding followed the removal of its placenta, the patient dying of collapse. In Cooke's⁴ case the extra-uterine sac obstructed the pelvis, but was displaced by manipulation under chloroform, and the uterine foetus delivered by traction after version. The mother died, however, of septic peritonitis two days after delivery.

Worrall⁵ has recorded a case in which he removed an extra-uterine foetus weighing 4½ pounds, which had been dead for about two years, from the left meso-

¹ Chrobak, see Ludwig, *Wiener klin. Wchnschr.*, 1896, ix. No. 27, 600.

² H. P. C. Wilson, *Amer. Journ. Obstet.*, 1880, xiii. 821.

³ G. C. Franklin, *Brit. Med. Journ.*, 1894, i. 1019.

⁴ L. R. Cooke, *Trans. Obstet. Soc. Lond.*, 1864, v. 143.

⁵ R. Worrall, *Med. Press and Circ.*, 1891, i. 296.

metrium. The placenta was left, and the sac drained. The intra-uterine child was born next day, but lived only a few hours. The patient made a good recovery.

Stonham,¹ in a post-mortem examination on a woman forty-three years of age, who died in the seventh month of pregnancy from bronchitis and ulceration of the trachea, found a lithopaedion in the right mesometrium. Some of the bones were completely macerated, and the soft structures were of a soapy consistence. There was a thin deposit of calcareous material on the inner wall of the sac. The left mesometrium was normal. The uterus contained a seven months' foetus, which was apparently living at the time of its mother's death, as it was not at all macerated.

In a case reported by Gordon² it was necessary to incise the posterior vaginal wall, and remove the extra-uterine foetus, before delivery was possible. In Cheston's case the intra-uterine foetus was delivered with great difficulty with the crochet, and after this, an abscess burst, and with the pus some of the bones of the extra-uterine foetus were discharged. In Sanger's case, Caesarean section was rendered necessary by the presence in the pouch of Douglas of an old ectopic gestation-sac, surrounded by numerous adhesions, and rendering the delivery, by the natural passages, of a living child impossible. A similar operation was performed by Hugenberger for labour obstructed by an ectopic sac in the pelvis, with a favourable result to the child, but followed by the death of the mother; and in a patient operated upon in the same way by Schauta, the obstruction was produced by a lithopaedion impacted in the pelvis. The mother recovered, but the child, affected with a myelomeningocele, died on the fourth day.

Ahern³ has recorded a case in which a living child was delivered by Caesarean hysterectomy, and a full-term dead foetus which had obstructed labour was removed from a sac situated behind and to the right of the uterus.

The Effect of Ectopic Gestation upon subsequent Pregnancies.—From a study of 188 cases of intra-uterine pregnancy occurring in 127 women who had had an ectopic gestation, Funck-Brentano concludes that the uterine pregnancy usually pursues a normal case in those patients who have been treated by operation, but that subsequent pregnancies are often complicated in those patients who have been treated without operation. Of such complications, abortion is the commonest, and supuration of the old sac is the most dangerous. Among 147 pregnancies occurring in 92 women who had had an extra-uterine gestation, not treated by operation, artificial delivery was required on thirteen occasions, three times by version, four

¹ C. Stonham, *Trans. Path. Soc. Lond.*, 1887, xxxviii. 445.

² See L. Funck-Brentano, "Des grossesses uterines survenant apres la grossesse extra-uterine," These de Paris, 1898, with bibliography.

³ J. M. Ahern, *Bulletin Med. de Quebec*, 1908-1909, x. 49.

times by forceps, once by induction of premature labour, twice by craniotomy, and three times by Caesarean section. One patient died undelivered. Of 34 women who had 40 pregnancies, after having been operated upon for an extra-uterine gestation, 30 were delivered spontaneously at full term, and 3 aborted, the fourth dying in the seventh month of a subsequent pregnancy, from a cause unknown.

MULTIPLE ECTOPIC PREGNANCY

Two varieties of this condition may be distinguished, depending upon the

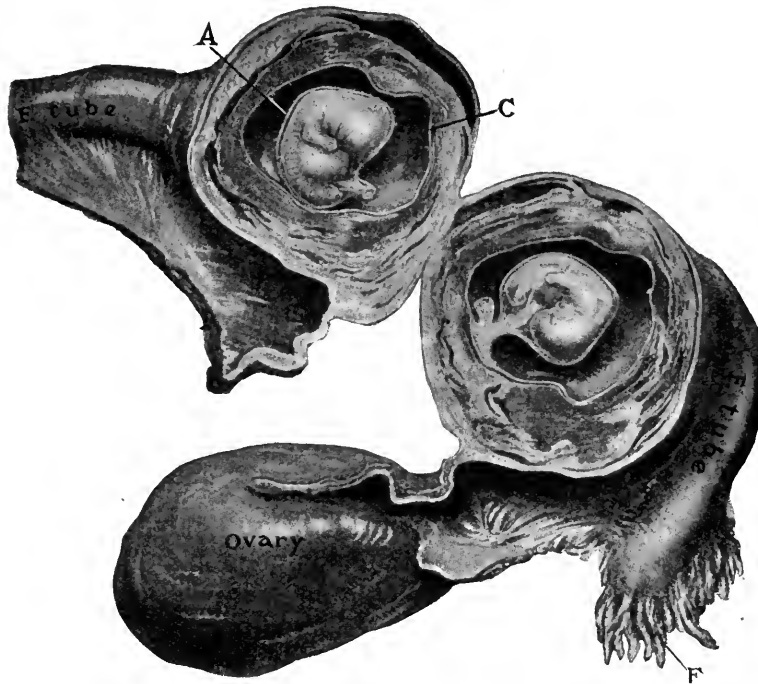


FIG. 228.—Specimen of twin tubal pregnancy. (S. J. Cameron, *Proc. Roy. Soc. Med.*, 1911, iv. Part 2, 149.)

A, Amniotic sac; C, chorion; F, fimbriated extremity of Fallopian tube.

position of the two embryos: there may be two or more in the one tube, or one in either tube.

A twin pregnancy in a single tube is a condition of considerable rarity, but McCalla,¹ in 1909, collected 25 cases, and since his paper was published other cases have been recorded. The two embryos may be contained in a single sac (Fig. 228), or in two separate sacs, and in the latter case, they may be attached to the tube-wall, as in the case recorded by Saniter, at a little distance from one another. The first arrangement appears to be rare, but well-marked examples of this kind have been

¹ L. P. McCalla, *Surgery, Gynecology, and Obstetrics*, 1909, viii. 248.

recorded by McCann,¹ Andrews,² and Bertino.³ Twin ova in the tube have been found not only in the early but also in the later months of a tubal pregnancy. In a case described by Krusen, the condition was one of triplets, the three foetuses, all about the second month of development, being found in the blood-mass of a haematocoele, the burst sac occupying the ampulla of the tube. In the remarkable case recorded by Folet, both foetuses were mummified: one had attained nearly to full term, while the other, of about three months' development, was flattened out against the sac-wall.

Cases of an embryo in either tube have only been met with in the early months of pregnancy, and McCalla has collected thirty-six instances of this bilateral form of tubal pregnancy. This term strictly should be limited to the condition where a tubal pregnancy, the result of simultaneous or nearly simultaneous conception, is progressing in both tubes, at the same time. Very few cases, however, have been recorded in which the embryos were apparently of the same age, so that most examples of so-called bilateral tubal pregnancy are in reality cases of repeated tubal pregnancy. In the 29 cases collected by Jayle and Nandrot,⁴ there is no certain instance of conception having occurred simultaneously in the two tubes, or that the pregnancies developed together.

A number of cases have been reported in which two gravid tubes have been removed from a patient at the same operation, but a critical examination has shown them to be of different dates, one progressing, the other old and quiescent.

A case has been recorded by Laurell⁵ of an operation on a multipara on account of early tubal abortion with a haematocoele, at which pregnancy was discovered in the other tube also. The histological examination is said to have shown such complete correspondence in the development and commencing degenerative changes in the chorionic villi in the two tubes, that the pregnancies must have commenced at the same time.

Repeated Tubal Pregnancy.—In 1885 Lawson Tait operated upon a woman, twenty-five years of age, and removed a gestation-sac with the foetus and placenta from the right side of the pelvis. The patient recovered, and eighteen months later was confined at term. Fifteen months after delivery, she became pregnant again, and at the fourth month she was seized with severe abdominal pain, and died in five hours. Since this date a number of examples of this accident have been recorded,

¹ F. J. McCann, *Journ. Obstet. and Gyn. Brit. Emp.*, 1906, x, 628.

² Russell Andrews, *Proc. Roy. Soc. Med. Lond.*, 1909, ii, Pt. 2, 228.

³ Bertino, *Annali di Ostet. e Gin.*, 1911, xxxiii, 719.

⁴ F. Jayle and Ch. Nandrot, *Rev. de Gyn. et de Chir. Abd.*, 1904, viii, 195.

⁵ B. Laurell, *Mitt. a. d. gynäk. Klin. d. O. Engström*, 1907–1908, vii, 141.

and most surgeons who have operated upon a series of cases of ectopic gestation have met with instances. It is remarkable that in some cases the pregnancy in the second tube has occurred within a short time of the operation on the first, as in the case recorded by Zangemeister, in which the clinical facts make it clear that the patient became pregnant again within a few weeks of her dismissal from the hospital. The period of liability would appear to vary from nine weeks to seven years, but the majority of the cases occur within a limit of four years from the date of the first pregnancy. Rabinovitz¹ has collected 147 certain cases of this condition. Among 1179 patients operated upon for tubal pregnancy, in 44 a second tubal pregnancy occurred. Ten of the patients had borne one or more children in the interval between the first and second ectopic gestations, 5 had become pregnant on second occasions, but had miscarried each time. One hundred and thirty-two had had no intra-uterine conception between the first and second ectopic.

It is possible for a patient to recover from an early tubal abortion without operation, and become pregnant again in the same tube. In a remarkable case recorded by Pearson,² a tubal pregnancy occurred twice in the same tube at an interval of four years, a normal full-term pregnancy intervening. At the first operation about one inch and a half of the tube was excised, the ligatured cut ends being left more or less in contact. An interesting example of the same kind was reported by H. C. Coe. In this case an interval of eleven years elapsed between the two pregnancies, and at the operation a recently ruptured, four months' pregnancy was found in the ampullary end, and a lithopaedion in the isthmal portion of the same tube. A corpus luteum was found in the ovary opposite to the pregnant tube, and as the lithopaedion completely occluded the tube, conception could only occur by external migration of the ovum.

CHANGES IN THE FOETUS IN ECTOPIC GESTATION

When we remember the frail character of the union of the placenta with the tubal wall, and how ill adapted the latter is to receive and nourish an ovum, it is not surprising that in a large number of tubal pregnancies the foetus dies at an early age. Even if the pregnancy does not terminate prematurely, the ovum still has to run the risks inseparable from such accidents as tubal abortion, or tubal rupture, and the proportion of cases which continue to develop for the first few months of pregnancy is small, and of those which survive to a later date it is smaller still. The saying of Werth that "the ovum when it makes its bed in the tube also digs its grave," is in

¹ M. Rabinovitz, *Amer. Journ. Obstet.*, 1911, lxiv. 238.

² M. G. Pearson, *Journ. Obstet. and Gyn. Brit. Emp.*, 1909, xvi. 114.

many respects true. When the embryo dies in the early stages of its development, in most instances it becomes absorbed, and disappears, and it is a common experience that, in many of the cases of tubal pregnancy operated upon, no trace of the embryo can be found.

Among the survivors of the perils of their surroundings, maldevelopments and malformations are common. In a series of cases of extra-uterine gestation, operated upon in the later months of pregnancy, collected by Sittner,¹ of 122 foetuses 17 were malformed, and in 5 cases the malformation probably played some part in causing the death of the foetus. Among 70 of the foetuses, 14 were of normal size, 37 were less well developed, and 19 were larger than intra-uterine foetuses of the same period of development. Of the 122 foetuses born alive 59 died within the first four weeks, and 63 survived for a longer period than this. Of the 63 who lived, 18 were lost sight of, 14 died within the first year, 8 in the second year, and the remaining 23 were alive and well at varying periods after the operation.

Winckel² states that in at least 50 per cent of extra-uterine foetuses malformations are present, and in 13 cases met with by this author all showed definite malformations. The head is most commonly affected, and the deformities, usually the result of external pressure, take the form of flattening, displacement, depressions, and fractures of the skull bones. Of 87 cases collected by Winckel, alterations in the form of the skull were found in 66 per cent, and hydrocephalus in 10 per cent. Among his cases the head was affected in 75 per cent, the pelvis and lower extremities in 50 per cent, the upper extremities in 40 per cent, and the thorax, abdomen, and genitalia in 3 to 4 per cent (Fig. 229).



FIG. 229.—A deformed extra-uterine foetus, found free in the peritoneal cavity, from a patient who was four months pregnant. (U. C. H. Med. Sch. Museum, No. 719.)

It is difficult to determine with certainty whether these deformities are, as Werth believes, the result of malnutrition of the developing foetus, owing to the imperfect formation of the maternal portion of the placenta, and the liability to haemorrhages and necrosis of the maternal tissues, or are due to mechanical causes, such as lack of room, oligohydramnios, and the presence of amniotic adhesions. Werth maintains that the foetus in the early months of an extra-uterine gestation is as well developed

¹ A. Sittner, *Arch. f. Gyn.*, 1908, lxxxiv. 1.

² v. Winckel, *Über die Missbildungen von ektopisch entwickelten Früchten*, Wiesbaden, 1902.

as an intra-uterine foetus of the same age, and he believes that the factors which interfere with its further normal development only come into play in the later months of pregnancy. It must be remembered that at any rate some of the deformities are produced *post mortem*.

Anomalies of the membranes and placenta are not uncommon in ectopic gestations. Oligohydramnios has already been mentioned as a possible cause of malformation, and the opposite condition of hydramnios has also been described in a few cases. Cases of hydramnios occurring in an extra-uterine gestation have been recorded by Webster, Teuffel, and Lindfors.¹ In the last case the sac contained some 11 to 12 litres of fluid. Costa² has collected 6 cases of eclampsia complicating this

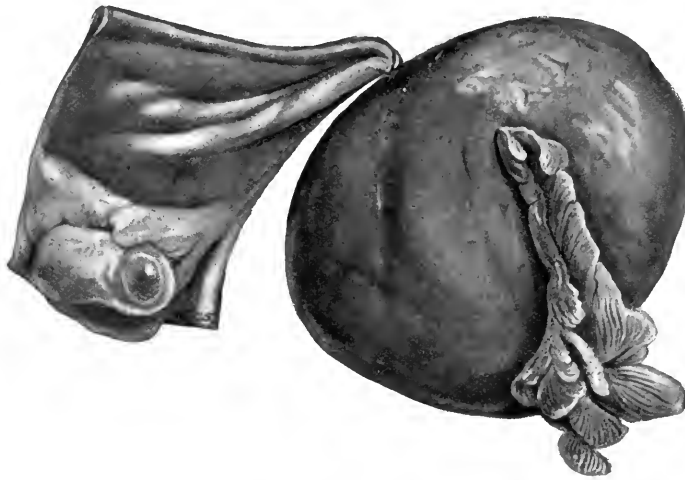


FIG. 230.—A tubal gestation-sac which has undergone axial rotation.
(Royal College of Surgeons Museum, No. 462.)

condition, including one of his own. A small number of cases of hydatidiform degeneration of a tubal ovum are reported in the literature, and Cope and Kettle³ have collected 14 cases of chorionepithelioma involving the tube, and have also reported a case of their own. Another case has recently been published by Bazy.⁴ In many of these cases there is a history pointing to tubal gestation, and no doubt this was an antecedent condition in some of them. In a case recorded by Löfqvist⁵ the patient had been operated upon in 1906 for a tubal abortion and the tube preserved. In 1908 symptoms of a fresh tubal pregnancy developed; at the operation the ovum was found in the same tube, and on microscopical examination

¹ A. O. Lindfors, *Zentralbl. f. Gyn.*, 1902, No. 26, 711.

² R. Costa, *Annali di Ostet. e Ginecologia*, 1908, ii. 85.

³ V. Z. Cope and E. H. Kettle, *Proc. Roy. Soc. Med. Lond.*, 1912, vi. Pt. 2, 247.

⁴ L. Bazy, *Annales de Gyn. et d'Obstét.*, 1913, x. 208.

⁵ Löfqvist, *Zentralbl. f. Gyn.*, 1909, No. 44, 1534.

it showed the early stages of a chorionepithelioma. That this was so in all is difficult to prove, and in some the growth may have followed an unrecognized intra-uterine pregnancy.

Other rare anomalies which may occur in cases of pregnancy in the tube are torsion of the tube, or the presence of the tube in the sac of a hernia. Cases of twisting of the pedicle have been described by Martin, Pozzi, and McCann (Fig. 230).¹ In the latter case the tube was the seat of a haematosalpinx, in the wall of which chorionic villi were detected on microscopic examination.

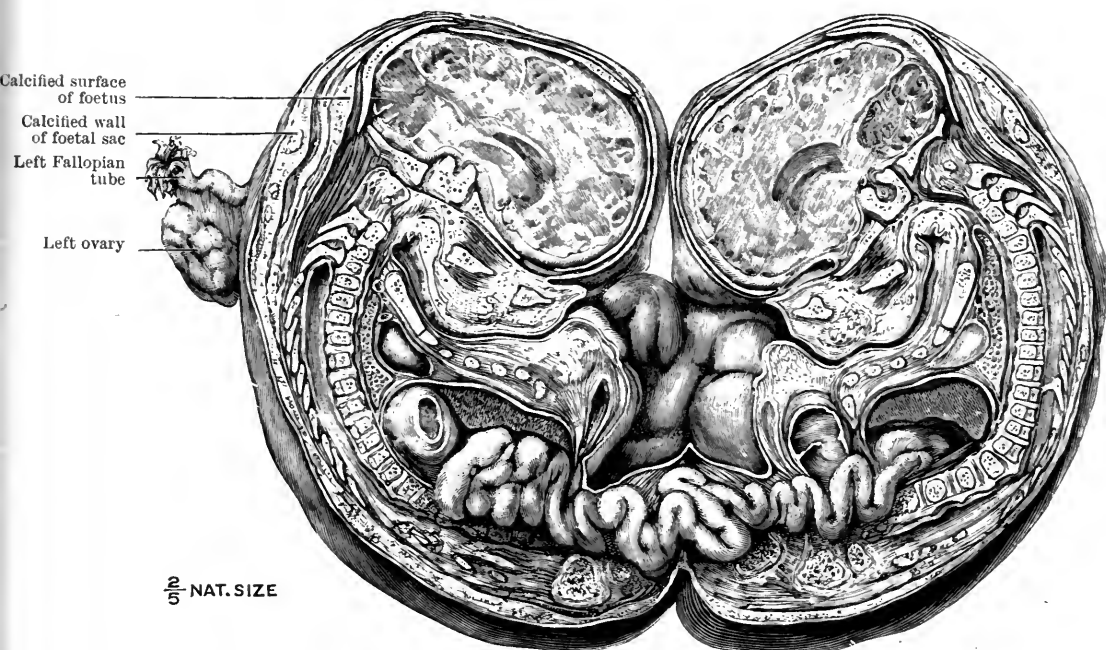


FIG. 231.—Foetus retained twenty years in a calcified broad-ligament sac. (Galabin.)

The changes which occur in the foetus retained in the body after its death, depend upon the nature of its surroundings, and the presence or absence of micro-organisms in the tissues. Maceration, mummification, skeleton-formation, calcification, and the transformation of parts of the tissues into adipocere may all take place. Maceration is only possible in the absence of organisms, and differs in no way from that seen in intra-uterine foetuses. Mummification is a common occurrence in the case of foetuses retained for long periods of time in the abdominal cavity. In these cases the liquor amnii becomes absorbed and the tissues are desiccated. Mummified foetuses are of a greyish-yellow colour, the skin is wrinkled, and the skeleton can be readily seen through

¹ J. McCann, *Lancet*, 1903, i. 1298.

it. The foetus, compressed in the false sac, which is usually present, and which is formed by adhesions, generally with the addition of the amnion, lies curled up in the abdomen; and after a time, the sac becomes so closely applied to it that it forms, as it were, a false skin (Fig. 231). The absorption of the fluids of the tissues is carried out by the newly-formed vessels in the sac-wall. Dense adhesions, the result of chronic peritonitis, may be present between the sac and the surrounding viscera, or the



FIG. 232.—A lithopaedion removed from the abdominal cavity of a woman in which it had been retained for more than fourteen years. (Royal College of Surgeons Museum, No. 476.)

abdominal walls. Skeleton formation can occur both with and without accompaniment of suppuration. In the latter case the soft parts are destroyed by the action of phagocytes, and of a certain cellular enzymes. More commonly suppuration occurs, the inner surface of the sac is converted into a layer of granulation tissue, and the soft parts of the foetus are gradually destroyed by phagocytosis and autolysis. The destruction of the tissues takes place first, as Werth has pointed out, in those parts of the foetus, usually on its dorsal aspect, which are in close contact with the sac-wall.

When suppuration occurs, the placenta usually disintegrates and finally disappears, so that if the abscess cavity is opened, no trace of it may be found. When pus forms in the sac it becomes adherent to the surrounding tissues, and the abscess points through the intestine, vagina, bladder, or the abdominal wall, portions of the foetal tissues being gradually discharged. In a few instances the entire foetus has escaped through an opening at the umbilicus, either spontaneously or with the aid of the surgeon. Suppuration is especially liable to take place in intra-pelvic sacs in close relation with, and adherent to, the rectum.

Lithopaedion.—The deposit of lime salts, usually carbonate and phosphate of lime, in the membranes or the superficial tissues of the foetus leads to the formation

of the so-called lithopaedion, or stone-child. In the commonest variety of this condition, the *lithokelyphopaedion* of Küchenmeister, calcification takes place both in the membranes and in the superficial layers of the foetal tissues, where they are adherent to the membranes or to the false sac. Cases of pure lithokelyphos, in which the deposit of lime salts occurs only in the membranes, and the foetus is simply mummified, are probably not so common as Küchenmeister thought (Fig. 232).



FIG. 233.—Lithopaedion and calcified placenta (*p*), retained fifteen years in the abdomen and eventually causing acute intestinal obstruction. (J. W. Smith, *Journ. Obst. and Gyn. Brit. Emp.*, 1908, xiii, 180.)

In a true lithopaedion the foetus is generally in the abdominal cavity, surrounded by a false membrane and adhesions. The deposition of the lime salts occurs primarily in the deeper layers of this membrane, as the result of interference with the circulation through it from thrombosis of the vessels, and secondarily invades the foetal tissues. The lime salts are mainly in the connective tissue of the sac, and the invasion of the foetal tissues occurs at the points of adhesion of this membrane. No doubt in some cases areas of calcification may be met with, scattered throughout the tissues of the foetus (true petrification), but this is certainly exceptional.

When bodies are buried in moist positions, a peculiar body called *adipocere* is sometimes formed, and the same substance may be met with in extra-uterine foetuses. This change takes place in the subcutaneous fat, and also, on occasions, in the fat of the other organs and tissues. Adipocere, fat-wax or grave-wax, is a substance formed by the combination of fatty acids with alkaline earths and ammonia, and is composed mainly of ammonium margarate with an admixture of potassium and calcium margarate. Clark¹ operated successfully on a case in which the foetus weighed $4\frac{3}{4}$ pounds; most of its tissues had undergone saponification, but the surrounding membrane was calcified in parts, and there were areas of calcification in the lungs and skin of the foetus.

The occurrence of a lithopaedion formation was well known to the older writers, and one of the best-known cases is that recorded in the *Gynaecia* of Israel Spach, 1595, with a figure showing the lithopaedion *in situ* in the abdomen. Such a tumour may remain quiescent for many years, and may never cause trouble, as in the case recorded by J. W. Smith. This case is of particular interest as the calcified placenta was also found in the abdomen (Fig. 233); in most cases of lithopaedion formation it has entirely disappeared. In Küchenmeister's case the foetus had lain in the abdominal cavity for fifty-seven years. Leopold² has recorded a very remarkable case of a woman who had seven children. After the fourth child she had, according to the evidence, an extra-uterine pregnancy, then three more intra-uterine children, and she lived to the age of seventy years; at the necropsy a sequestered foetus, which she had carried for thirty-five years, was found.

SYMPTOMS OF ECTOPIC PREGNANCY

The symptoms and physical signs of an ectopic gestation vary, not only with the nature of the pregnancy but also with the stage of development to which it has advanced. It will be necessary, therefore, to consider them under the following divisions: first, before the rupture, or the abortion of the pregnancy; second, at the time of the occurrence of a rupture or abortion; third, when the pregnancy proceeds to the later months; fourth, when the patient has passed the period of full term.

1. Before Rupture or Abortion.—The history given by an intelligent patient is often of great assistance, particularly if it is suggestive of past attacks of chronic pelvic peritonitis, or of a previous attack of gonorrhoea, while the presence of dysmenorrhoea, and of chronic pelvic pain, especially if it is unilateral and accom-

¹ J. G. Clark, *Bull. Johns Hopkins Hospital*, 1897, viii. 221.

² Leopold, *Arch. f. Gyn.*, 1882, xix. 210.

panied by a long period of primary or secondary sterility, is evidence of the presence of some, at any rate, of the predisposing causes of an extra-uterine gestation.

The patient perhaps thinks that she is pregnant, but feels that there is something amiss, and if a multipara, she is aware of the fact that this pregnancy differs in some ill-defined way from those preceding it. Morning vomiting or nausea may be present, but some writers maintain that this symptom is not so constant in an extra-uterine as in an intra-uterine pregnancy. If this is so, the explanation may lie in the early interruption of the pregnancy, or in the death of the ovum, or in the age and multiparity of the patient.

Mammary changes may be slight or well marked; their positive is greater than their negative value. In a multipara who has had a child recently, the presence of a little secretion in the breast, or some pigmentation of the areola is obviously not a sign of any value. The fact of there being not uncommonly some secretion in the breasts in cases of pelvic inflammation, or tumours of the ovaries, must be borne in mind.

The most important and constant of the *symptomatic signs* is the occurrence of some degree of the amenorrhoea of pregnancy, as this is entirely wanting in only a few of the cases. In most there is a history that the patient has gone at least a few days over the time of her expected period before the onset of the symptoms leading her to seek advice. Tubal rupture or tubal abortion may, however, occur before the date on which the next period is due, or on the very day on which it is expected. In other cases slight irregular haemorrhages from the uterus occur at a very early date, so that the patient loses count of her normal periods. Among 79 cases recorded by Winter amenorrhoea was present in 67. In 3 cases the periods returned during pregnancy, in 7 haemorrhage from the uterus occurred before the date of the expected menstruation, and in 2 on the expected day of the flow. Among 76 cases collected by Hamilton Bell, in 16 the first symptoms occurred during the proper intermenstrual period, in 17 when the period was due, or within a day or two of the proper date, in 43 within a variable time from five weeks to two months or more after the last period.¹ The value of this symptom is obviously much greater when it occurs in an otherwise healthy woman, whose periods have been previously quite regular.

One of the most constant of the symptoms of a tubal pregnancy before its rupture, is spasmodic attacks of unilateral pelvic pain, and this is a particularly valuable sign when associated with the subjective symptoms just mentioned. Pain may have been present for some time as a result of old chronic pelvic peritonitis;

¹ See also S. M. Mackenzie, *Journ. Obst. and Gyn. Brit. Emp.*, 1911, xx. 277.

if so it is aggravated, but in other cases its onset coincides with that of the pregnancy, and it is due to the distension of the tube by the growing ovum, or to small haemorrhages into the wall, or the interior of the tube. Attacks of pain of this kind are often associated with slight, irregular haemorrhages from the uterus, and may then have their origin, as some authorities think, in uterine contractions.

The symptoms typical of a tubal pregnancy, however, do not, as a rule, occur until some complication has made its appearance, such as rupture of the sac, or tubal abortion.

2. At the Time of Rupture or Abortion.—In cases in which *the sac ruptures, and free intraperitoneal haemorrhage takes place*, the onset is often very sudden and correspondingly alarming. A woman previously healthy, who has possibly missed one or two periods, or has only had a few days' amenorrhoea, is seized with a sudden attack of acute pain in the abdomen, and all the signs of internal haemorrhage. The pain may come on quite without any cause, or may follow slight traumatism of some kind, such as a blow, a fall, some straining effort on the part of the patient, or sexual intercourse. The attack of pain is accompanied or followed by intense pallor and utter prostration; the patient faints, or complains of a feeling of great faintness; her mucous membranes are blanched, the pulse is small, rapid, and thready, and the respirations are feeble, hurried, and shallow. There is a sense of impending death, and the extremities become cold and clammy. The temperature is sub-normal, the expression is anxious and haggard, and the condition very critical. If the internal haemorrhage continues, the severity of the symptoms increases, and the patient's condition becomes more and more serious; yawning, hiccough, and vomiting occur, the mucous membranes lose all their colour, great restlessness ensues, and fatal syncope ends the scene. The intellect is usually clear up to the end. So rapid is the occurrence of death in some cases that the true state of things is not suspected. The suddenness of the onset, and the severity of the attack, not infrequently lead to the suspicion that the case is one of poisoning, or that perforation of one of the hollow viscera, such as the stomach, has occurred. Death may occur in a few hours or in so short a time as twenty minutes, as in a case under my own observation. At the present day the lives of these patients are usually saved by an immediate operation, but in a few instances they recover apart from operation, with or without the cessation of the ectopic gestation.

In cases in which a *tubal abortion* occurs, and a typical *peritubal haematocoele* forms, paroxysmal attacks of pain occur, usually accompanied by the symptoms of more or less severe internal haemorrhage, and by bleeding from the uterus. The attacks of pain are no doubt due to the haemorrhages which occur into the wall

and lumen of the tube, and into the peritoneal cavity. They are present, and often severe and characteristic, in cases in which the blood is still confined to the tube, and has not escaped into the peritoneal cavity. In this case they are probably due to the stretching of the tubal walls by the haemorrhages, and to colicky contractions of that part of the tube not occupied by the ovum. If the amount of blood effused is considerable, there is faintness almost amounting to syncope, nausea, and vomiting, and later the signs of pelvic peritonitis appear.

The pain may be dull and continuous, or paroxysmal, with recurring exacerbations; it is usually sudden in its onset, and at first severe. If the tumour is a large one there may be a feeling of weight and pressure in the pelvis, retention of urine, and frequent desire to empty the bowel, with tenesmus and the passage of mucus. The lower part of the abdomen especially is tender and distended. Slight jaundice may be present, no doubt haematogenous in origin, and urobilin may be present in the urine. A dull white pallor, the result of the haemorrhage, is often well marked and almost characteristic. After the early severe symptoms are past, the patient may manifest those of pelvic peritonitis with some elevation of temperature and a rapid pulse. In some cases the blood escapes so gradually that a typical peritubal haematocele may be found on examining the pelvis, when the patient is seen for the first time, and as such a tumour may form with few or only slight symptoms, it may be impossible to determine the date on which the first attack of haemorrhage occurred.

Haemorrhage from the uterus usually accompanies, or may follow, the internal bleeding, and is often associated with the discharge of the uterine decidua. This haemorrhage is one of the most trustworthy of the confirmatory signs of an extra-uterine pregnancy, and it occurred in no less than 73 of 88 cases of tubal pregnancy collected by Hamilton Bell.

Weindler and Werth have drawn attention to the fact that the uterine bleeding may occur before the date of the expected period, at the time of the first period after the commencement of the pregnancy, or after an interval of some two or three months. The first two types are most commonly associated with cases of early tubal abortion, and the last type with a tubal rupture.

Haemorrhage from the uterus is therefore not only a most constant symptom, but is also very typical in its characters. It is usually slight in amount, although occasionally it may be severe, and resembles very closely a long-continued, scanty menstrual period. The blood is often mixed with mucus, rarely with pieces of tissue, and its escape occurs at the same time as the attacks of abdominal pain, or closely follows them. The usual source of the blood is the hyperaemic mucous membrane

of the uterus, but in some cases it seems clear that it has been derived in part from the tube, and has found its way through the uterine opening into the interior of the uterus. Continuous uterine haemorrhage is not necessarily an indication that the foetus is dead.

The passage of portions of the decidua from the uterus is also an important

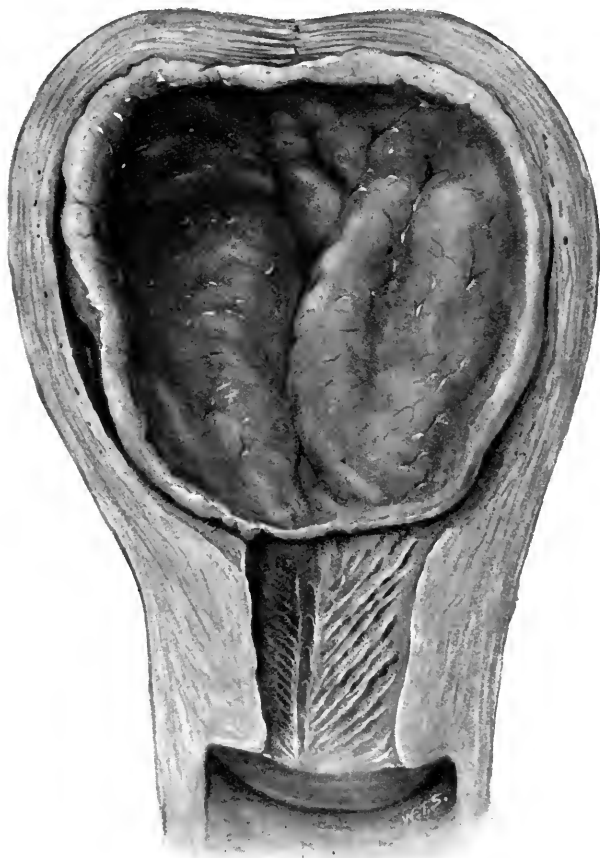


FIG. 234.—A uterus from a case of tubal pregnancy containing a well-formed decidua.

although not so constant a symptom, as the uterine haemorrhage. Among 276 cases of extra-uterine pregnancy collected by Winter, von Winckel, von Schenck, and Hennig, it occurred in 182 or two-thirds of the cases. The membrane is usually cast off in shreds or in two pieces corresponding to the anterior and posterior walls of the uterus, rarely as a complete cast of the uterine cavity. The recognition of the decidua is not difficult, but that the membrane is from a case of ectopic gestation is more difficult to determine, and may prove impossible, even with the aid of the microscope. It is said that in extra-uterine gestation, the decidual cells are smaller, the membrane as a whole thicker, and the glands are less numerous. The presence of any chorionic villi is of course clear evidence of an intra-uterine pregnancy.

The absence of decidual tissue from the discharge from the uterus is not proof that no extra-uterine pregnancy is present. Thus it was probably absent in no less than 71 of Hamilton Bell's 88 cases, but this proportion is exceptional. In cases of very early rupture or abortion no decidua may be passed, and it may be retained throughout in the uterus (Fig. 234). It is not, as a rule, discharged unless the tubal pregnancy is interrupted by tubal rupture, tubal abortion, or haemorrhage into the tube, or by operation; and when the foetus is retained till full term, the

decidua is generally expelled during the false labour characteristic of this period. Its expulsion does not prove the death of the foetus, as the latter may continue to develop even after the occurrence of rupture or abortion.

In the rare form of extraperitoneal rupture in which the wall of the tube is eroded, and the cellular tissues of the broad ligament are gradually opened up by the growing ovum, the shock is much less marked, the symptoms are less severe, and are comparable rather to those attending the formation of a peritubal haematocoele. The great difficulty in these cases is to be sure that the bleeding is purely extraperitoneal. In some cases rupture of the tube into the peritoneum accompanies the haemorrhage into the cellular tissue of the broad ligament.

3. When the Pregnancy proceeds.—If the patient does not die as a result of rupture of the tube, and is not operated upon, and if the foetus continues its development as a secondary abdominal gestation, or as one of the other rarer forms of ectopic pregnancy, the usual signs of pregnancy may persist. Attacks of abdominal pain are frequent, due partly to the gradual distension of the sac, possibly in some instances to its contractions, more especially in cases of cornual pregnancy, and partly to the pelvic peritonitis which is almost always present. As the pregnancy proceeds still further, the certain signs of foetal life will be found, such as foetal heart-sounds and foetal movements, but the absence of intermittent uterine contractions, and the fact that the uterine souffle, if present, is not heard in the usual position, are noteworthy. The foetal heart-sounds will be heard over the position of the foetus, but the location of their greatest intensity may not bear its usual anatomical relation to the uterine souffle. The foetal outline may be readily palpable, and in some cases it is possible to map out the placenta by abdominal palpation with considerable facility (Fig. 233). If in such a case the patient is suddenly seized with abdominal pain and signs of internal haemorrhage it is indicative of secondary rupture of the sac.

When full term is reached, if the child is alive at that time, a kind of sham labour takes place, and uterine contractions, accompanied by action of the abdominal muscles, separate and expel the decidua. A blood-stained discharge from the uterus sets in, which may last for some time. The child usually dies within a few days of the onset of this sham labour, but in a few cases movements of the child have been described as continuing for a short time after its occurrence. It is rarely that rupture of the sac is caused by the sham labour, but some haemorrhage may take place into it. The pains are no doubt due to the uterine contractions, as the wall of the sac contains but a very small amount of muscle tissue, and they are accompanied by some dilatation of the cervix. The false labour lasts a variable time, usually only a few

days, but it is said to have lasted for weeks in some patients, before subsiding. Milk may continue to be secreted in the breasts for some weeks.

4. After Full Term.—After the death of the foetus, degenerative changes occur in the placenta, the circulation through it becomes interrupted, and the liquor amnii absorbed, the membranes becoming closely applied to the body of the child, which undergoes mummification, the soft parts being converted into a greasy pulp, or changed into adipocere. The abdomen diminishes in size from the shrinking of the sac, and as time goes on, the formation of a lithopaedion may take place, or the sac



FIG. 235.—Tubal gestation-sac which ruptured at the fourth month of pregnancy.
(Royal College of Surgeons Museum, No. 466A.)

may suppurate, and its contents escape externally by the abdomen, the rectum, the vagina, or the bladder. Of these the external opening is the most favourable, that into the rectum the commonest; the process of evacuation may be prolonged for years, if not assisted artificially, the bones coming away piecemeal. Eventually the patient may recover, or may succumb to peritonitis, or to chronic septic infection.

THE DIAGNOSIS OF ECTOPIC GESTATION

The diagnosis of an extra-uterine gestation may be a comparatively simple affair, or may tax to the utmost the skill of the surgeon. The symptoms and physical signs vary so much at different periods of the pregnancy, both before and after changes have occurred in the sac, or before and after the death of the foetus,

that it is necessary to discuss in some detail the chief diagnostic features present under these varying conditions.

1. Before Rupture.—It is not often that a tubal pregnancy is diagnosed before rupture, but it is possible to do so, and in many cases the history is found to be quite typical, and the patient herself suspects that she is pregnant. Not infrequently, however, she is not aware of the fact, and the practitioner may be deceived by the absence of some of the symptomatic signs of pregnancy, such as amenorrhoea and mammary changes. The breast signs are especially variable in cases of ectopic gestation. In many they are absent even when the pregnancy has advanced to mid-term, in others they are as clear and well marked as in an ordinary intra-uterine pregnancy. Age is naturally of some importance in the diagnosis, and according to Bland-Sutton, more cases occur between the twentieth and twenty-fifth year than between the thirty-fifth and forty-first year. It is not uncommon in the previous history of the patient to find evidence of old pelvic trouble, such as some disturbance of the puerperium, symptoms suggestive of an attack of pelvic peritonitis, or of gonorrhoea, or a long period of sterility. At the same time it must be remembered that a very similar history can be obtained in almost any case of pelvic inflammation.

The most important and constant symptoms of a tubal pregnancy before its rupture are spasmodic attacks of unilateral pelvic pain—and this is a particularly valuable sign when associated with the subjective symptoms mentioned—and a period of amenorrhoea. If a patient seeks advice with a history of a missed period or of irregular haemorrhage, and of pelvic pain, and a tumour suggestive of an enlarged tube is found, then the presumption is in favour of a tubal pregnancy (Fig. 236). The enlargement of the tube is usually of a spherical shape (Fig. 235), movable at any rate in the early stages, and the mass feels soft and doughy rather like blood-clot, and does not fluctuate. In ampullary pregnancies it is sometimes possible to trace the unaffected portion of the tube into the swelling, and the fact, when it can be detected, that the uterine end of the tube is not thickened, serves as a help in distinguishing a gravid tube from one enlarged by inflammatory changes. Even at an early stage, however, slight haemorrhages into the interior of the tube may render the swelling hard and well defined. The accompanying slight softening of the cervix and enlargement of the uterus, with the absence of Hegar's sign, are valuable confirmatory signs when they are present.

2. Rupture.—In cases of rupture of the gravid tube the general symptoms are such as to lead at once to the suspicion of severe internal haemorrhage, while the abdominal symptoms call the attention of the surgeon to the abdomen. This is usually distended and extremely sensitive to pressure; there may be slowly shifting

dulness in one or both lumbar regions, or at times above the pubes. No fluctuation or fluid thrill can, however, be obtained. On an internal examination, which must be carried out with great care and gentleness, a diffuse swelling or merely increased resistance, can be detected in Douglas' pouch. The gestation-sac itself can only occasionally be felt—more easily when haemorrhage has occurred into it, and when it is situated low down in Douglas' pouch or at the side of the uterus. A history of premonitory attacks of unilateral pain, succeeded by intense abdominal pain more

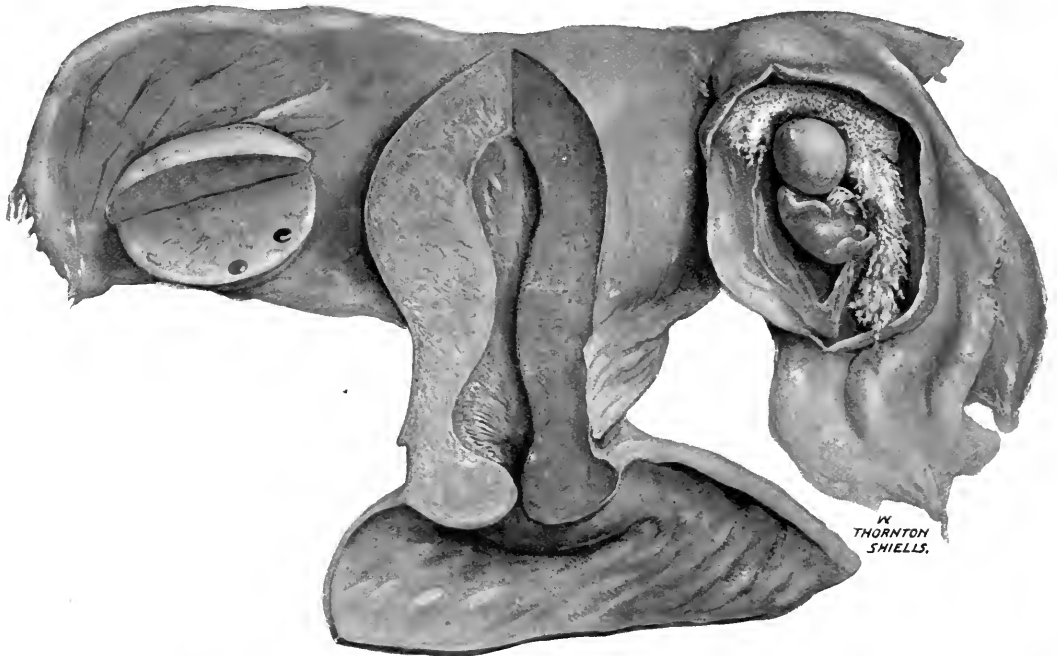


FIG. 236.—A tubal pregnancy at about the eighth week of gestation; the posterior wall of the sac has been partly removed and the membranes opened. (U.C.H. Med. Sch. Museum, No. 699.)

or less diffuse, and sometimes the patient's statement that she felt something giving way, will also be of assistance.

The condition most often mistaken for profuse internal haemorrhage following the rupture of a gravid tube is peritonitis, the result of rupture of one of the hollow viscera. Both conditions are likely to be associated with collapse, abdominal pain, and vomiting, but there is not the same degree of anaemia in the patient suffering from peritonitis, and the vomiting is a more persistent, and a more prominent symptom. One of the most characteristic features in the history of a case of tubal rupture with severe haemorrhage is usually that the patient was previously quite healthy. In most cases of peritonitis due to the rupture of one of the viscera there is a previous history pointing to a diseased condition of the particular organ affected. Too much

stress must not be laid upon the regularity or otherwise of the menstrual periods: a girl suffering from a gastric ulcer, for example, is often anaemic, and may be suffering from amenorrhoea. It is, however, more common for the surgeon to mistake a ruptured tube for a perforation of a viscus than for the gynaecologist to make the opposite mistake, and this tends to show that when a careful history is taken, and the practitioner is alive to the possibility of an ectopic gestation being present, a certain diagnosis can often be made. In all cases of doubt an exploratory laparotomy should be practised; the suggestion of puncturing the pouch of Douglas with a hollow needle in order to demonstrate the presence of blood is not one to be approved. After the abdomen is opened whatever condition is found can at once be dealt with, and as an immediate operation is indicated whether the patient is suffering from internal haemorrhage or perforative peritonitis, no time should be lost in carrying this out.

3. After Rupture or Abortion.—The differentiation of the various kinds of haematocele is attended with extreme difficulty, and in the majority of the cases it is impossible to determine with certainty any other cause for these tumours than a tubal gestation.

In the diagnosis of a pelvic haematocele, the result of a tubal abortion, the greatest reliance is to be placed upon the history. There has been a period of amenorrhoea, followed by typical haemorrhage from the uterus, with the passage of shreds of decidua or of a cast of the uterus, so that the patient often thinks she has had an abortion. She complains of spasmodic attacks of pain in the lower abdomen, accompanied by a feeling of faintness and followed by anaemia, at times of a severe type. Great tenderness and some swelling of the abdomen are present, and there may be difficulty in the passage of both urine and faeces. Mammary changes may be found, and a tumour felt in the pelvis, behind or to the side of the uterus, recognizable by its shape, tortuosity, and feel, as the distended tube. There may be marked pulsation in the vessels on the same side, and concurrently with the attacks of abdominal pain, the tumour increases in size, and acquires the characters of a peritubal or retro-uterine haematocele.

Pestalozza and Spinelli¹ regard the presence of acetone in the urine as a valuable sign, and particularly if it appears and disappears, as they believe its reappearance coincides with fresh attacks of haemorrhage.

Uterine Abortion.—A not uncommon mistake in a case of tubal abortion, and one often made by the patient herself, is that she is having, or has had, an ordinary uterine abortion. In both cases there will be abdominal pain, in both haemorrhage from the

¹ P. G. Spinelli, *Arch. ital. di Ginec. Napoli*, 1909, xii, 361.

uterus and the passage of shreds of decidua. A suspected early uterine abortion with severe attacks of spasmodic abdominal pain should always be regarded with suspicion, since this type of pain is not usual in early abortions. Careful enquiry will generally elicit the fact that the pain is more colicky in character than that accompanying menstruation or the early stages of labour.

A diagnosis is to be made by a careful examination of whatever is passed, if necessary with the microscope, and a careful pelvic examination, which will reveal the presence of a gestation-sac. The history will help, and in a still doubtful case a careful examination under an anaesthetic, and if no tumour of the adnexa is found, an exploration of the interior of the uterus. Any pelvic or other examination in a suspected case of ectopic pregnancy must be conducted with the utmost care. A uterine sound should never be passed if it can be avoided, and the suggestion made by some gynaecologists that the uterus should be explored and curetted is a dangerous one. A curettage carelessly carried out may lead to the rupture of a gestation-sac and a very severe haemorrhage, and even when skilfully and successfully performed gives information of very little value. The changes in the decidua may not be typical; in very early cases there may be no decidual reaction present, and even under the microscope, it is often difficult to distinguish between the decidua of an intra-uterine and of an extra-uterine pregnancy.

Uterine Pregnancy with Enlarged Ovary or Tube.—Before rupture or abortion has occurred a tubal pregnancy may be mistaken for an enlarged ovary or tube, especially if these are present with an intra-uterine pregnancy. In both cases there will be a history suggestive of pregnancy, changes in the uterus, and the symptomatic signs of pregnancy. A careful examination will possibly reveal that the tumour in the lateral fornix has not the typical feel and consistence of a tubal gestation, and that the changes in the uterus are too marked to be compatible with an extra-uterine gestation, or that the uterus is large. In any case of doubt, as a tumour of the tube or ovary is more often mistaken for a pregnant tube than the reverse, a second examination after an interval of a few weeks will usually enable a correct diagnosis to be made.

Pyosalpinx.—Inflammatory enlargement of the tubes, a pyosalpinx for example, may be readily mistaken for a peritubal haematocele. In most instances menorrhagia accompanies a pyosalpinx, but in a few cases, when the condition is bilateral and accompanied by chronic inflammatory changes in the ovaries, there may be amenorrhoea. Not only may the swelling formed by a pyosalpinx closely resemble that formed by a peritubal haematocele, but the symptoms due to the rupture of a pyosalpinx may very closely resemble those due to a pregnant tube. In both cases

there may be a sudden onset, with collapse, abdominal pain, vomiting, and signs of peritonitis. The previous history of the patient is of great importance; if the swelling be a pyosalpinx she will probably have had repeated attacks of pelvic peritonitis, and may have been in ill-health for some months or years. In the case of a peritubal haematocoele one of the most important points is that previous to the attack the patient is usually in the best of health. Points in favour of the inflammatory nature of the swelling will be the presence of fever, a more continuous but less intense type of pain, a history suggestive of gonorrhoea, and involvement of the opposite side.

Appendicitis.—In cases in which the gestation-sac is situated on the right side, confusion may arise with inflammation of the appendix. A careful investigation of the history and the presence of the cardinal symptoms of appendicitis, namely pain beginning in the epigastrium and spreading to the iliac fossa, vomiting, general abdominal tenderness, and special tenderness over the appendix region, with a rise of temperature, and in some cases leucocytosis, should help in leading to a correct conclusion, especially if the symptoms definitely come on in this order. The absence of any rise of temperature, or of any symptoms suggestive of previous trouble in the appendix, the presence of marked anaemia, and possibly slight jaundice, are in favour of a ruptured tubal gestation. In the majority of cases the swelling present in an attack of appendicitis is extra-pelvic, while that due to a tubal pregnancy is intra-pelvic, but the reverse may be the case if the appendix is hanging over the pelvic brim, or the tube is adherent in the iliac fossa, and it is just in such cases that difficulties arise.

Retroverted Gravid Uterus.—The swellings most likely to be mistaken for a pelvic haematocoele or a gestation-sac are those situated in the posterior half of the pelvic cavity, occupying the pouch of Douglas. The most important of these is an incarcerated, retroverted gravid uterus. In both cases there is a period of amenorrhoea, in both there may be haemorrhage from the vagina, and in both the patient may complain of pains in the abdomen, and of pain in passing water. A careful investigation of the history of the case must be made. In the patient with an incarcerated uterus, a period of amenorrhoea of three months at least usually elapses before symptoms are present leading her to seek medical advice; in the haematocoele, on the other hand, it may be but a few weeks. The character of the bleeding from the vagina will also help; in the case of the haematocoele, as has already been pointed out, the blood is dark-coloured, and the flow more continuous than in the case of the incarcerated uterus; in the latter instance, when an abortion is threatened, the haemorrhage is more likely to be excessive, the blood lost to be bright red, to contain clots, and to be associated with uterine

contractions. An abdominal examination will show the distended bladder, and the passage of a catheter will prove this with certainty. By a careful bi-manual examination the elastic tumour filling up the pouch of Douglas will be felt, and the absence of the body of the uterus from its normal position determined. The gravid uterus is more uniform, better defined, its outline more regular, it is softer, and it may present intermittent contractions. The upper border of the haematocele is generally irregular and ill-defined, it is less movable than the uterus, and the gradual change in its consistence which takes place as the blood clots more completely, is lacking in the case of the uterus. The position and direction of the cervix, and possibly the fact that its direct continuity with the pelvic tumour can be demonstrated, will prove of assistance. A correct diagnosis is of the greatest importance, as an attempt to replace the haematocele under the impression that it is a retroverted uterus may lead to its rupture, with disastrous results. In cases where the uterus is very closely fused with the anterior surface of the haematocele, or is surrounded by the blood, the utmost difficulty may be experienced, and in such cases the patient should be examined under an anaesthetic.

Pelvic Cellulitis.—The condition of all others which bears the closest resemblance to an effusion of blood into the broad ligament, or a pelvic haematoma, is that met with in a case of pelvic cellulitis. This condition, following labour at full term or an abortion, is usually associated with some inflammatory condition of the uterus or appendages. It is not accompanied so frequently by haemorrhage from the uterus, nor by pallor and faintness, and the swelling at first is situated more deeply in the pelvis, is slower in formation and harder on palpation. A haematoma, on the other hand, begins more suddenly, and soft at first becomes harder later, or becomes soft again if it suppurates. An important point of difference is that the constitutional symptoms follow a different order in the two cases—the febrile disturbance precedes the formation of the cellutic swelling, and follows that of the effusion of blood. If suppuration in a haematoma occurs a correct diagnosis may be quite impossible.

Ovarian and Uterine Tumours.—The various forms of ovarian and uterine tumours are rarely mistaken for a collection of blood in the pelvis. They are to be distinguished by the absence of urgent symptoms at the time of their formation, by their slower growth, by their circumscribed form, and by their mobility. Suppuration in an ovarian cyst may lead to a masking of the original form of the tumour by peritonitic changes around it, and so the soft centre with the hard periphery may simulate the physical signs of a haematocele. Haemorrhage into an ovarian cyst with or without twisting of the pedicle, may give rise to all the signs of internal haemorrhage and the rapid production of anaemia. In such a case the

history and the possible knowledge that a tumour was present before the attack will be of assistance. The smoothness and uniformity of the mass, the absence of a swelling in the pouch of Douglas, the presence of any of the signs of pregnancy, and the fact that the ovarian cyst is less likely to be closely connected with the uterus, must all be given due consideration in the attempt to make a correct diagnosis.

Serous Effusion.—A condition which so far as the physical signs go closely resembles a pelvic haematocele is a serous effusion in the pelvis as a result of pelvic peritonitis. Here the history of the case and other evidences of an inflammatory exudation must be relied upon in clearing up the diagnosis. The possibility of a haematocele complicating a malignant growth in the pelvis must be borne in mind, as cases of this kind have been recorded by Gardner and by Playfair.

Intra-Uterine Pregnancy.—An intra-uterine pregnancy is not uncommonly mistaken for an extra-uterine, and the latter is often suspected when it is not present, a mistake which is particularly likely to be made in the middle and later months of the pregnancy.

The early pregnant uterus often assumes abnormal shapes, especially in the relaxed condition, and a superficial examination may lead to the suspicion that, for example, an elongated cervix really represents the unenlarged body of the uterus, and that the soft pregnant body is an extra-uterine sac. In the same way the eccentric development of the uterus, not uncommon when the insertion of the ovum is at one cornu, is readily mistaken for a gestation-sac lying close to the lateral border of the uterus. Both these conditions are not infrequently met with, and may prove puzzling unless the patient is examined under an anaesthetic, or on several occasions, and changes in the consistence or the shape of the uterus detected, revealing the true nature of the case. In these, as in all cases of doubt in the early months of pregnancy, a little patience and an examination on another occasion will usually prevent a mistake being made.

The presence of the symptomatic signs of pregnancy, and possibly those of a threatened abortion, will render the likelihood of error still greater, and it is therefore not surprising to find mistakes often made by the practitioner.

4. During the Advanced Stages of the Pregnancy.—Even when a diagnosis of an extra-uterine gestation has been established it is, in many cases, only with great difficulty that a certain conclusion can be come to as to whether the pregnancy is continuing or has come to an end. The question of the proper treatment to pursue may depend upon a correct answer to this question.

A further difficulty is introduced by the fact that an increase in the size of the swelling may be due, not only to the continued growth of the ovum, but also to the

occurrence of further haemorrhages into or around the sac. It is in the early weeks, before the certain signs of foetal life are present, that the difficulty arises.

If the symptomatic signs and the other changes in the genitalia subside, and if there is no recognizable increase in the size of the swelling, the presumption is that the ovum has ceased to grow ; but, on the other hand, the persistence of the symptomatic signs, or the increase in the size of the swelling, are not by any means certain signs that the ovum is still alive. The question is not, however, practically of very great importance, because if the swelling increases in size operative interference is generally indicated, whether the embryo is still developing or not. Such an increase generally signifies that the patient is subjected to the risk of further serious haemorrhage, and therefore steps should be taken to prevent any such danger.

When the pregnancy persists beyond the mid-term the presence of signs of foetal life, such as the foetal heart-sounds, will afford evidence of the life or death of the child, and in these the question is one not of the presence of a living foetus but rather of its position—is it intra-uterine or extra-uterine ?

At first sight it would seem that there should be no difficulty in coming to a conclusion, and in most instances this is so. Occasionally, however, cases occur in which a correct diagnosis before the abdomen is opened may be exceedingly difficult, particularly in the case of dead foetuses lying between the layers of the broad ligament or subperitoneally.

In a case, for example, of tubo-abdominal pregnancy, the variety in which the question is most likely to arise, the presence of intermittent uterine contractions in the coverings of the foetus will prove that it is the uterus, and an attempt should always be made to elicit these. Lawson Tait has drawn attention to cases in which the walls of the uterus were so thin that the foetus could be easily felt. In an attempt to make a diagnosis the first thing is to try and define the position of the body of the uterus, if necessary under an anaesthetic, and its relation to the foetus. The presence of the uterine souffle in an abnormal anatomical relationship to the position of maximum intensity of the foetal heart sounds, the absence of the marked changes in the cervix and vagina which should be present in a case of pregnancy of such an advanced age, and, by an examination through the rectum, the relation of the cervix to the swelling are all important points to determine. The movements of the foetus may cause undue pain to the mother. If the child is dead, and especially if it is lying between the layers of the broad ligament, or under the peritoneum, great difficulty may arise. If the child is certainly dead, the passage of a uterine sound will be permissible. In a broad-ligament gestation the sac is closely adherent to the uterus, and generally bulges down the lateral fornix.

If the case is one in which the patient has passed the period of full term the diagnosis is usually more or less certain. There will be a history of a false labour, the cessation of the signs of pregnancy, and gradual diminution in the size of the abdomen and of the tumour. The uterus, not much enlarged, can be distinguished apart from a tumour of considerable size, often in close relationship to it, in which the parts of the child can be recognized. If, however, the wall of the sac has been thickened by inflammatory changes, and the foetus has been dead some time, a correct diagnosis may be extremely difficult to make.

Attention has already been directed to the great difficulties that may arise in diagnosis when an intra-uterine and extra-uterine pregnancy exist at the same time. In a case recorded by Galabin,¹ fluctuation was detected to the right of the pregnant uterus, which corresponded in size to that of an organ between the sixth and seventh months of pregnancy, and on deep pressure a more solid mass could be felt. There were signs of general peritonitis, and the diagnosis of pregnancy complicated by a ruptured ovarian cyst was made, although the possibility of the co-existence of an intra-uterine and extra-uterine gestation was suggested, and the latter condition was found on opening the abdomen. In Cooke's case (see p. 478) the fact that two foetal hearts could be heard, led Spencer Wells to diagnose an intra-uterine twin pregnancy, although an extra-uterine had at first been suspected.

Additional methods of diagnosis which have become available of recent years are the use of the X-rays and Abderhalden's serum reaction of pregnancy.² The latter method, properly carried out, may be very helpful in the early months of an extra-uterine pregnancy, if the ovum is alive. An X-ray photograph may enable the exact anatomical relations of the foetus in the later months to be determined, as in cases recorded by Imbert (1908), Sjögren (1904), von Lichtenstein (1906), Zurhelle³ (1912), and others. At the same time it must be remembered that in a number of cases—chiefly, however, in early cases photographed with inefficient apparatus—the X-rays have failed to give any certain information, and unless the position of the uterus can be demonstrated by the passage of a sound into it before the photograph is taken, it may be impossible to say from the radiogram whether the foetus is situated inside or outside the uterus.

TREATMENT

The treatment of ectopic gestation has become more and more surgical as our knowledge of its pathology has increased, so much so indeed that there are some writers

¹ A. L. Galabin, *Trans. Obstet. Soc. Lond.*, 1881, xxiii. 141.

² H. Williamson, *Journ. Obstet. and Gyn. Brit. Emp.*, 1913, xxiv. 211.

³ E. Zurhelle, *Zentralbl. f. Gyn.*, 1912, No. 36, 1177.

who recommend that all cases should be treated by immediate operation. There are, however, many problems to be considered, depending upon the duration of the pregnancy, and its variety, whether the patient is seen before or after its interruption, and whether with a living or a dead child. At a time when the causation of collections of blood in the pelvis was hardly understood, and the important fact that in the great majority of the cases they were due to ectopic gestation was not recognized, expectant treatment was the vogue. It is undeniable that with simple rest in bed very large effusions of blood will become completely absorbed, and no doubt many gravid tubes abort, and give rise to no more than a moderate amount of disturbance which rest will cure. There remains, however, a very large number in which an operation is necessary to save the patient's life, or in which operative interference will shorten the period of convalescence from months to weeks.

The striking results which have followed the surgical treatment of cases of early ectopic gestation have served to place this procedure on as secure a foundation as the operation of ovariectomy. The risks and difficulties depend mainly on the extent to which the gestation has progressed at the time of operation.

Before Primary Rupture or Abortion.—Opportunities of dealing with cases in this stage are uncommon, as gravid tubes rarely cause trouble before they rupture or abort, but if the diagnosis is made, immediate operative interference should be carried out, as the patient with an extra-uterine gestation is on the brink of a precipice, and may lose her life almost without warning before there is time to interfere. The interests of the mother must alone be considered, and the diseased tube removed at once, either by the abdominal or vaginal route, preferably by the former.

Various methods have been suggested from time to time for the purpose of destroying the foetus by the puncture of the sac, the injection of solutions of drugs into it, or the passage of strong electric currents through it; but these are only mentioned to be condemned, and are indeed at the present time obsolete.

It was Joulin in 1863 who first proposed to inject a solution of strychnine or atropine into the sac, and Friedrich in 1864 injected a solution of morphine into a tubal pregnancy. According to Depaul, Dubois first advised the killing of the foetus by electricity in normal pregnancy when grave accidents threatened the life of the mother. In 1865 Braxton Hicks attempted to destroy the foetus in an extra-uterine gestation of three and a half months by two applications of the galvanic current, but failed.

At the Time of Rupture or Abortion.—The majority of cases of tubal pregnancy come under observation at the time of primary rupture or abortion, and this is usually

at some period between the fourth and twelfth weeks. According to Whitridge Williams, W. W. Harbert,¹ in 1849, was the first to suggest laparotomy for the purpose of arresting haemorrhage from a ruptured tubal pregnancy, and Stephen Rogers,² also an American writer, wrote in 1867, "the peritoneal cavity must be opened and the bleeding vessels ligated." Parry, in his work on extra-uterine gestation published in 1876, urged the necessity of operation, but Lawson Tait, in 1883, was the first to adopt the suggestion, and to operate successfully for this condition.

In 1891 Schauta³ collected a large series of acute cases, and showed that among 123 cases operated upon there was a mortality of only 5·7 per cent, while among 121 cases treated palliatively the mortality was as high as 86·89 per cent.

When the symptoms of haemorrhage are unmistakable, and the patient's life is in great danger, abdominal section should be performed at once, and the ordinary rule of surgery followed to cut down upon the bleeding point. Preparations for the operation should be made as rapidly as possible, and if the condition of the patient is very grave it may have to be performed in her bed. Whenever possible, however, the patient should be removed to a hospital or a nursing home, as if her life is to be saved the surgeon must do his work in the most favourable conditions.

As soon as the peritoneum is exposed the dark blood will generally be seen showing through it. If, as usually happens, the view is obscured by the escaping blood which gushes out, the fingers should be passed into the pelvic cavity by the side of the uterus, and the appendages rapidly explored and the affected tube drawn up. The broad ligament should at once be clamped with Spencer Wells' or Doyen's pressure-forceps to arrest the bleeding. The removal of the tube either in whole or in part can then be carried out at leisure. In early cases it will usually be possible to ligature the mesosalpinx and remove the tube alone, the ovary being preserved. If the tissues are extensively damaged it may be necessary to remove the ovary as well, but this should be avoided if possible. In a very early case with only a small rupture it may be possible to excise only a portion of the tube; but the proposal put forward by Martin and others to express the ovum through the abdominal end in cases of tubal abortion, or to enucleate in a tubal rupture, and then to preserve the tube, after sewing up any rent that may be present, is not to be recommended. The opposite appendages should be carefully examined and always left if possible. The chances of a subsequent tubal gestation occurring on the opposite side are so small (some 5 per cent), as compared with the chances of a subsequent intra-uterine

¹ W. W. Harbert, *Western Journ. Med. and Surg.* Louisville, 1849, iii. 110.

² S. Rogers, *Tr. Am. M. Ass. Phila.*, 1867, xviii. 85.

³ Schauta, *Beiträge zur Casuistik, Prognose, und Therapie der Extrauterinenschwangerschaft*, Prag, 1891.

pregnancy (amounting to some 50 per cent), that the tube and ovary should always be preserved.

If the rupture involves the uterine wall it may be necessary to excise a wedge-shaped piece of the uterine cornu, the raw surface being carefully closed by deep silk or catgut sutures.

Arrangements should be made for an assistant to carry out intravenous saline infusion during the operation if required, as the condition of the patient is often desperate from the loss of blood. If the appliances are at hand, and it is feasible to carry it out, intravenous ether anaesthesia should always be employed for these cases. It has the great advantage that the anaesthesia and the infusion are carried out at the same time, and it has proved most successful in our hands.

If the condition of the patient is not very grave the surgeon is justified in removing the fluid blood and clots from the peritoneal cavity as completely as possible, but this is not essential; and in grave cases the more quickly the operation is finished the better for the patients, and the blood, provided that the operation has been carried out aseptically, quickly becomes absorbed and gives no trouble.

In cases of severe intraperitoneal bleeding it is the usual custom of surgeons in this country to operate at once without delay, and the results obtained by this method are extremely good. At University College Hospital, in the years 1902 to 1912 inclusive, 18 cases of rupture of the gravid tube with severe intraperitoneal haemorrhage have been operated upon with one death. In this case a pyosalpinx on the opposite side was overlooked and ruptured eleven days after the primary operation; and although the abdomen was reopened, the patient died seven days later from septic peritonitis.

Jacobs,¹ as the result of an enquiry in Belgium, gives statistics of 615 cases operated upon in the first few hours following rupture, with 27 deaths, or a mortality of 4.42 per cent. Ladinski² records 200 operations for ectopic gestation with three deaths, two of these occurring after deferred operations; and Taylor, Tait, and Robson record 107 cases of all kinds operated upon with four deaths.

In the face of these results, and in view of the fact that from time to time patients do die from haemorrhage as a result of the rupture of a gravid tube, it is difficult to recognize any sound arguments for deferring operation. It is true that the condition of the patient is often so serious that recovery seems impossible, but it is also true that apparently the most hopeless cases recover very quickly when the haemorrhage has been arrested and saline transfusion to remedy the loss of blood carried out, and

¹ Ch. Jacobs, *Bull. de la Soc. Belge de Gynécologie et d'Obstét.*, 1909-1910, xx. 39.

² L. J. Ladinski, *Journ. Amer. Med. Assoc.*, 1912, lix. 854.

no doubt some of the shock is directly due to the irritation of the peritoneum by the blood poured out into it. Some writers maintain that it is better to defer operation until the patient has recovered to some extent from the shock, and that the results of deferred are as good as those of immediate operations. Although in many cases the first haemorrhage does not prove fatal, yet it is generally impossible to say with certainty that it has ceased, and expectant treatment even increases the risk of a subsequent bleeding, while the patient is never safe until the bleeding point has been properly dealt with. No obstetrician of any experience can have failed to see cases in which the patient died in a short time from the intraperitoneal bleeding, even in so short a time as twenty minutes, as in a case under my own observation, and the great majority of them undoubtedly practise immediate operation in all these cases.

Most surgeons prefer the abdominal route, and it has the advantage of enabling the operator to determine the exact conditions more certainly, and this is especially advantageous if a mistake in the diagnosis has been made; it also enables him to deal with the effused blood more perfectly, and to take any steps that may be necessary to deal with any complications present. There are, however, some warm advocates of the vaginal route—for instance, Dührssen,¹ who has operated upon 93 cases in this way with only 2 deaths, 1 not directly due to the operation, and Spinelli,² who records 94 cases with 4 deaths.

The latter suggests that colpotomy may be employed as a means of diagnosis, of prophylaxis, or of treatment. This route is rapid and safe, and the tube can be palpated and, if necessary, brought down into the vagina by direct traction or by bringing down first the fundus of the uterus. The majority of surgeons prefer, and will continue to prefer, the abdominal route, more particularly in all cases where there is any doubt about the diagnosis, and with this view we agree.

In operating upon a case of interstitial pregnancy it is usually necessary to remove a wedge-shaped piece of the cornu of the uterus of larger or smaller size. In some cases even this is not sufficient, either because of the size of the sac, or because of the difficulty in arresting the haemorrhage, and it becomes necessary to perform a supra-vaginal or a total abdominal hysterectomy. In cases in which the bleeding is troublesome to control, this is often the best way out of the difficulty; but whenever possible a portion of the body of the uterus should be left to prevent the complete cessation of the periods. In any case of interstitial pregnancy which has advanced beyond the second month, removal of part of the uterus in this way is usually a

¹ A. Dührssen, *Deutsche med. Wchschr.*, 1908, xxxiv. No. 25, 1094.

² P. G. Spinelli, *Arch. ital. di Ginec. Napoli*, 1907, ii. 201.

matter of necessity. The vaginal route in this class of ectopic gestation is contra-indicated.

When a Haematocele has been formed.—In some cases of rupture of the tube the patient may recover from the immediate severe symptoms, and come under observation at a later date,¹ or immediate surgical interference may not be considered necessary. This condition is, however, more likely to occur in cases of tubal abortion with the formation of a *peritubal* or a *retro-uterine haematocele*. In these cases, when the patient has recovered from the first effects of the bleeding, it is often most difficult to come to a correct conclusion as to the after treatment. If the ovum is still developing, whether in the early or late stages of the pregnancy, or if the tumour increases in size with the signs of recurrent haemorrhages, then the case must be treated by operation. If, however, the ovum appears to be dead, and the tumour does not increase in size—that is, if there is cessation of growth, cessation of haemorrhage, and cessation of pain—the case may be watched until it is seen whether the blood-clot shows any signs of becoming absorbed or not. If after a sufficient lapse of time this does not occur, or if symptoms arise indicating that suppuration has taken place in the swelling, an operation must be undertaken.

The question of immediate surgical interference is not one that admits of settlement by mere statistical results, as these are much the same whether the patient is treated expectantly or by operation. We have seen how small the actual danger to the patient's life is in cases treated by immediate abdominal section, even when the patient is suffering from severe haemorrhage, and it is still less in uncomplicated cases of pelvic haematocele, for which expectant treatment also gives extremely good results. Champneys, Zweifel, and Thorn have recorded 234 cases treated expectantly with 1 death, and these figures may be compared with those already given, of 200 cases of operation for ectopic gestation (Ladinski) with 3 deaths. At University College Hospital, in the years 1902–1912, 78 cases of pelvic haematocele have been under observation; of these 64 have been treated expectantly with no deaths, and 14 by operation with no deaths. Other factors must therefore be taken into account in attempting to decide this question. One of these is the social position and surroundings of the patient. Can she afford to lie up for the length of time required to allow a large collection of blood to become absorbed? The average duration of such a case varies considerably, but is usually many weeks, or even months—a considerable period of time for a poor woman, and perhaps a bread-winner, to be laid aside from work. Although such a consideration must not be given undue weight yet it must be taken into account, especially when we remember how safely

¹ P. Lequeux, *L'Obstétrique*, 1911, n.s. iv. 493.

these collections of blood can be dealt with by operation. A further point to be borne in mind is that even when the tumour has become almost completely absorbed, or has diminished to a very small size, the patient is not necessarily cured. She may, and occasionally does, suffer some disability from the presence of the diseased tube, or from the adhesions and the inflammatory masses which may persist in the pelvis. The normal relations of the pelvic organs are not always entirely regained, and in cases where the haemorrhage is associated with a somewhat advanced ectopic gestation, remains of the foetus may be found many months after its death.

The investigations published by Scanzoni into the after histories of 119 patients, treated expectantly by laparotomy, and by colpotomy respectively, demonstrate that, as regards capability for returning to their ordinary work, and subsequent fertility, there is little to choose between these methods of treatment.

While the general statement remains true that practically all cases of haematocele due to an early tubal gestation will ultimately undergo absorption; yet the difficulty of a correct diagnosis, the length of time required, the risk of repeated and possibly very severe haemorrhages, the liability to suppuration occurring, and that the patient may suffer some subsequent disability, and the comparative safety attending immediate operations for their removal, render it difficult to deny that a very good case can be made out for the removal of such collections of blood by early operation. It must also be borne in mind that an operation undertaken after some weeks of delay may be much more difficult owing to the presence of dense adhesions, and the collection of blood is less likely to be sterile.¹

An operation, however, of necessity entails an abdominal or vaginal scar, probably ligatures on stumps and further adhesions, all with their accompanying drawbacks.

If an operation is decided upon it should, on general principles, always be of as conservative a character as possible, and the ovaries should never be removed if it can be avoided.

If it be decided to adopt *palliative measures* only, the most important of these is complete and sufficiently prolonged rest in bed. The greatest care must be taken to keep the patient absolutely quiet, and all movement on her part must be interdicted. If there are any signs that the bleeding is continuing, an injection of morphia should be administered, and an ice-bag placed upon the abdomen. When

¹ For a good *résumé* of the arguments for and against operation in these cases the reader should consult the papers by Hamilton Bell, Champneys, and Suhr in the *Journ. Obstet. and Gyn. Brit. Emp.*, 1906, x. 514, 1902, i. 585, and 1908, xiii. 261; also a critical review by Cuthbert Lockyer in the same journal, 1902, ii. 173.

the patient has recovered from the immediate effects of the bleeding, and it has been decided to try the effect of prolonged rest in bed, the future treatment of the case is of the most simple kind. Absolute rest must be insisted upon, the bowels kept gently open daily, and the variations in the size of the blood-mass carefully watched. The employment of hot vaginal douches, and the use of ichthyol and glycerine plugs, may be of some assistance, but anything that leads to the unnecessary disturbance of the patient must be carefully avoided.

If the surgeon decides to operate either because he believes that the best interests of the patient are served by immediate operation, or because the physical signs point to the continued growth of the ovum, or to the occurrence of further haemorrhages, he has a choice of two routes, the abdominal and the vaginal.

All cases of uncomplicated haematocèles, especially those definitely encapsuled, should be treated by abdominal section, and the vaginal route should be reserved for cases in which there is any evidence of infection, or in which suppuration has certainly occurred. The abdominal operation has the great advantage that the operator can, with more certainty and with greater safety, remove the diseased tube and the blood-clot, and preserve, if possible, the ovary ; he is also in a better position to deal with the adhesions which are almost always present, and which may be extremely difficult to separate, and to obtain a clear view over the whole field. The vaginal route has the great disadvantage that the softness of the tissues, due to the pregnancy, renders it extremely difficult to do more than evacuate the blood-clot, and the diseased tube must often be left. The haemorrhage also is often troublesome to control, and may necessitate either opening the abdomen or removing the uterus by the vagina.

In dealing with these cases by laparotomy, the operator must remember that part of the false sac-wall is usually formed by the intestine, and great care must be taken in separating adhesions not to damage the bowel, which is often soft and peculiarly lacerable. In many cases the capsule gives way and the blood escapes ; this is of no importance so long as the collection of blood is sterile. It is unnecessary to attempt to remove the capsule, if it is difficult to do so ; it is sufficient to remove the damaged tube. The pedicle should be tied with care, as the tissues often tear readily, and the ligatures are apt to cut through. If there is troublesome oozing from the walls of the cavity left after the removal of the blood-clot, or if much of the capsule has to be left behind, the posterior fornix should be opened, and the cavity plugged with a gauze drain, the end being brought out of the vagina. In this way it is generally possible to avoid drainage by the abdomen. The gauze drain (some form of antiseptic gauze being employed) should be slightly loosened each day, and removed entirely on the fifth day. The blood-clot should be removed as completely as possible

for fear of infection, especially when it is necessary to employ vaginal drainage. It is a good plan carefully to collect all the clots, and afterwards by carefully washing them out in water to search for the foetus or the mole.

The vaginal route is particularly indicated in old haematocoeles which bulge down into Douglas' pouch, or in any case in which there is evidence of septic infection or of suppuration in the collection of blood. If on opening the abdomen a pelvic abscess is discovered, secondary to suppuration in a haematocoele, it is a wise plan carefully to wall off the general peritoneal cavity with gauze, to cleanse the parts as carefully as possible, and to desist from any further manipulations. A temporary dressing should be applied, the patient put up in the lithotomy position, and the abscess opened and drained from the vagina. The operator can then return to the abdominal wound, and after cleansing it carefully, close it, leaving a small gauze drain passing down to the upper part of the sac or to the opening into it. This drain can be removed, if no untoward symptoms arise, at the end of forty-eight hours, and a small drainage tube substituted. In such a case no attempt naturally should be made to wash out the cavity from the vagina, and all manipulations should be carried out with great care, so as to avoid any of the pus finding its way into the general peritoneal cavity.

If it is decided to proceed by the vaginal route from the first, a *posterior colpotomy* should be practised. The posterior lip of the cervix is fixed with a volsellum and drawn forwards. In many cases the bulging swelling can be felt in the middle line; if not a vertical incision through the vaginal mucous membrane should be made in the middle line, about half an inch behind the cervix, with a scalpel. A pair of moderately blunt dressing forceps, or Spencer Wells' forceps, should then be pushed up, keeping them close to the uterus, into the swelling, and if pus or blood escapes opened as they are withdrawn so as to enlarge the incision. A finger may then be passed in to explore the cavity carefully, and the blood-clot it contains evacuated with care, no violence being used, and if it is apparently well shut off it may be washed out with sterile water or salt solution. A plug of iodoform gauze should then be introduced and kept in for five or six days, being carefully loosened a little each day. At the end of this time the cavity may be irrigated daily, and care must be taken to keep the vaginal opening patent until the discharge has entirely ceased. A large-size rubber drainage tube may be substituted for the gauze drain, the precaution being taken to fix it with a silkworm-gut stitch passed through the posterior lip of the cervix.

If severe haemorrhage occurs from the cavity, and it cannot be checked, it is occasionally necessary to open the abdomen, but this is quite exceptional. Any bleeding from the edges of the incision can be controlled by plugging or by mattress

sutures. This method of treatment gives extremely good results, and certainly shortens the period of convalescence.

If the diseased tube can be removed without undue difficulty, this may be done, but if not, it may safely be left, in the expectation that in the majority of cases the patient will make a complete recovery.

Extraperitoneal collections of blood or pelvic haematomata may be treated in the same way if they bulge into the posterior vaginal fornix. Care must be taken to incise the vagina in the middle line, and if the mass is mainly in the lateral fornix it is usually possible to strip up the peritoneum from the posterior wall of the uterus, so as to reach the collection of blood without endangering the uterine artery or the ureter. If in the early months on opening the abdomen the tumour is found to be a pelvic haematoma, it is a good plan to close the abdomen and to evacuate it through the vagina. If the swelling extends above Poupart's ligament like a pelvic cellulitis, it may be opened in this position, without opening the peritoneum, by an incision such as is made for the ligature of the external iliac artery. This variety of haematoma is, however, very rare, and immediate operative interference is seldom necessary. When the pregnancy is in the early months, and occupies mainly the upper part of the broad ligament, it is at times possible to excise the whole sac either with or without the uterus, including the embryo, placenta, tube, ovary, and the blood-clot, as in a case recorded by Silles and Poux.¹ Any adhesions there may be are ligatured, the ovarian vessels on the outer side are ligatured, the broad ligament between the sac and the uterus is then secured, and if necessary the sac enucleated from beneath the peritoneum. Usually, however, the uterus must be removed as well, in order to control the bleeding effectually.

In the Later Months of Pregnancy.—In considering the treatment of cases of ectopic gestation in the later months a distinction is made by most writers between those cases in which the child is living and those in which the child is dead. This distinction is becoming of less and less importance, because in all cases the interests of the mother must be considered as paramount, and whatever operation is selected should be performed as soon as possible, so as to minimize the maternal risks to the greatest degree. The statistics collected by Sittner, however, have shown that the chances of an extra-uterine foetus being born alive and surviving are greater than might be expected, and other things being equal the chances of saving the child alive may be allowed some weight in coming to a decision.

There is still a great deal of difference of opinion, whether it is advisable whenever possible to allow some months to elapse after the death of the child, whether this occurs

¹ Silles and Poux, *Comp. Rend. de la Soc. d'Obstét. et de Gyn. de Paris*, 1909, xi. 218.

at or before full term, so as to permit of the placental circulation becoming arrested, or whether it is not better to operate at once, even if the child is alive, so as to save the mother the possible danger of septic changes occurring in the sac, or the risk, present so long as the pregnancy continues, of its rupture with sudden and acute haemorrhage.

It is impossible to lay down definite rules to cover all cases. A decision as to the best procedure to adopt must be based upon the exact nature of the pregnancy so far as this can be diagnosed, the general condition of the patient, whether the child is alive or dead, and if alive whether it is viable, and whether the mother is willing to run some increased risk for the chance of saving her child's life. The difficulty and danger of these operations depend upon the nature of the placental attachments, and whether it is possible to remove the placenta and the sac at the time of operation, or whether they have to be left to come away subsequently. The ideal operation is one performed at or near full term, in which it is possible to remove the whole sac and the placenta, and to save the child alive. Such an operation is at times possible, and the number of such successful cases is being added to every year.

In deciding upon the nature of the operation in the later months of pregnancy it is important, as Taylor has clearly pointed out, to distinguish between those cases in which the child is situated free in the peritoneal cavity within or outside the amnion, and those in which the child is situated in a sac outside the peritoneal cavity, as in an anterior or posterior subperitoneal pregnancy.

A tubo-abdominal pregnancy is the type of the first kind. In this form of pregnancy the child is often deformed and mal-developed from pressure; while in a subperitoneal gestation this is less often the case, and the child, if delivered alive, is more likely to survive. In dealing with a tubo-abdominal pregnancy the crux of the whole position is the placenta. Is the placenta mainly contained within the tube? Is it attached to the tube and its immediate neighbourhood in a more or less localized manner? Or is it spread out and attached to surrounding structures such as intestine and abdominal wall over a wide area? As Matthews Duncan pointed out, and as Taylor has fully confirmed, "there is no other site of placental attachment than the original site, no reason to believe that the placenta ever does or ever can change its site."

The recognition of this fact is of the utmost importance, and equally important is an exact knowledge of the manner in which the placenta is usually attached in this type of case in the immediate neighbourhood of the broad ligament. In operating in tubo-abdominal pregnancy the child is readily removed after the abdomen is opened. In a certain number of cases, those in which the placenta is still retained

within the tube, or closely attached to a limited area round the tube, it is possible by ligaturing the main vessels, the uterine and ovarian, to cut off the blood-supply sufficiently to allow the placenta to be removed without much loss of blood. The detachment should be commenced on the side on which it is easiest to get at the vessels, and after they have been ligatured it is often possible to clamp the attachments of the placenta with pressure forceps, and to remove it with comparatively little loss of blood. The clamped tissues are then tied and the abdomen closed with or without drainage as may be indicated.¹ When the placenta is attached over a wide area and to many different structures, including intestine, its detachment may prove impossible. Even in these cases, however, it should be attempted. The main area of attachment will usually be to one side of the middle line, and to get at the uterine vessels it may be necessary to remove the uterus by supra-vaginal amputation, or total hysterectomy, commencing on the sound side and so tying the uterine vessels of the affected side of the cervix, and enabling the placental attachments to be attacked from below, after the ovarian artery on that side has also if possible been ligatured. If this is impossible, then the placenta should be rapidly peeled up, the bleeding stopped by pressure with gauze pads, and such of the bleeding vessels as can be, picked up and ligatured, or pressure forceps applied, and left *in situ* for twenty-four hours, and then removed.

If plugging is required iodoform gauze should be employed and the site of the placental attachments tightly plugged with strips of this gauze brought out of the abdominal wound or through the vagina, whichever is most convenient. They should be loosened daily, and completely removed on the fifth day. In a case of this kind, in which the placenta can be removed, it will usually be possible to remove the whole or the major part of the sac at the same time. If the adhesions to the intestines and other parts are too dense to permit of their being separated, the remains of the sac should be attached to the edges of the wound and drained by gauze. In a case reported by Paterson,² at the sixth month, treated in this way, the drainage wound was soundly healed in a few weeks. He lays stress on the importance of not using any ligatures within the sac, as they are certain to become infected and delay convalescence.

A *tubo-abdominal pregnancy* with a diffuse attachment of the placenta is the most dangerous variety of all, and the most difficult to deal with. The case recorded by Savage³ is an interesting example of a *tubo-abdominal pregnancy* at full term,

¹ René Bloch, *Bull. de la Soc. d'Obst. et de Gyn. de Paris*, 1912, xv. 598; Cragin, *Surgery, Gynaecology, and Obstetrics*, 1912, xiv. 276; W. W. H. Tate, *Journ. Obst. and Gyn. Brit. Emp.*, 1906, x. 592.

² H. J. Paterson, *Proc. Roy. Soc. Med. Lond.*, 1909, ii. Pt. 2, 117.

³ T. E. Savage, *Proc. Roy. Soc. Med. Lond.*, 1912, v. Pt. 2, 72.

treated on these lines with almost complete removal of the placenta, with a successful result to the mother and child. The child, a male weighing 4 lb. 10 oz. at birth, had a slight torticollis and talipes equino-varus, but was quite well and healthy a year later.

A continued attempt to remove the sac in cases of this kind may be attended with great difficulty and considerable danger to the patient. Intimate adhesions to the intestines, ureters, and large vessels must be dealt with, and there is a great liability to immediate and remote complications. If it is possible either immediately or after a lapse of a short time to remove the placenta, the attachment of the sac to the edges of the abdominal wound ("marsupialization" as it is called) is attended with comparatively little danger. Violet¹ points out that the complete removal of the sac may be more surgical, but in difficult cases certainly less prudent.

If it is judged impracticable to remove the placenta at the time, then there are two alternative procedures which may be followed. The first consists in removing the child, tying the cord close to its placental attachment, disinfecting the stump carefully, sewing up the opening in the sac, and closing the abdomen, in the hope that the placenta, as occurs sometimes in cases of extra-uterine gestation in which the child dies at full term, may be absorbed without any untoward symptoms.² This hope is, however, very seldom realized, and for this reason this mode of treatment finds few advocates among modern writers. The second alternative is to remove the foetus, sew the margins of the sac to the abdominal wall, cut off the ligatured cord, and plug the sac with iodoform gauze. The gauze plug should be removed after a few days and renewed. At the end of three or four weeks an attempt may be made cautiously, under an anaesthetic, to remove the placenta,³ which is sometimes possible after this interval without much bleeding, and then the cavity repacked from time to time, and allowed to shrink up gradually. In a case in which the placenta has a large diffuse attachment, it is obvious that it may be impossible to sew the edges of the sac to the abdominal wall. In this case the placental site should be isolated as far as possible by gauze plugs, an attempt made at the end of a month or so to remove the placenta, and if successful, the cavity left again plugged, and allowed gradually to close up.

In dealing with these cases a valuable procedure in assisting to arrest haemorrhage at the time of the operation is to carry out compression of the abdominal aorta.⁴

In the treatment of *an intraligamentary pregnancy*, the complete removal of

¹ Violet, *Thèse de Toulouse*, July 1910.

² R. P. R. Lyle, *Journ. Obst. and Gyn. Brit. Emp.*, 1906, x. 596; H. W. Freund, *Zentralbl. f. Gyn.*, 1908, No. 12, 416.

³ L. Seeligmann, *Deutsche med. Wchnschr.*, 1906, xxxii. No. 22, 879.

⁴ Th. Landau, *Berl. klin. Wchnschr.*, 1906, xliii. No. 32, 1061.

the placenta is less important. In the anterior form (Fig. 237) it is often possible to incise the sac extraperitoneally, and after removal of the foetus it can be plugged, and the placenta left to separate without interference; or an attempt may be made to remove it after a short interval, when the vessels will be thrombosed, and the separation may be carried out with little bleeding (Berry Hart).

In an early case, as has been pointed out, it may be possible to excise the whole sac, but in the advanced stages this is seldom possible or desirable. If the exact

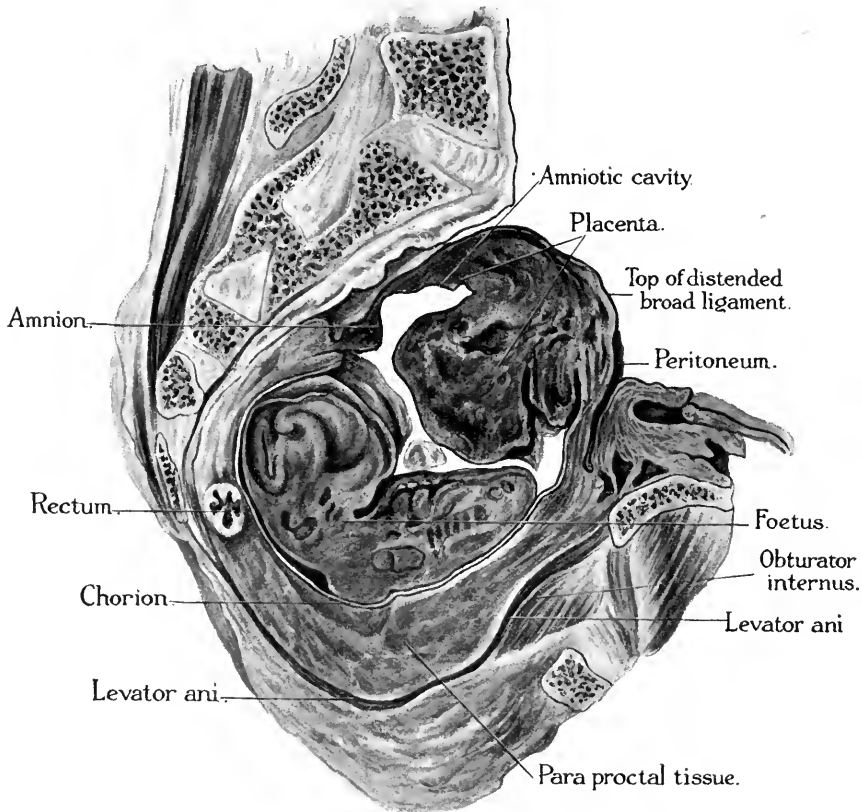


FIG. 237.—Intraligamentary pregnancy, mesial sagittal section, *in situ*. (Berry Hart.)

anatomical relations are not clear, it is best first to open the abdomen in the middle line, to determine the relation of the sac to the abdominal wall, and then to make another incision into it, extraperitoneally.

The foetus should then be extracted, the sac cleaned out and dried, and plugged with iodoform gauze. This can be renewed when necessary, and after an interval an attempt made to remove the placenta. If this is successful the further treatment consists in keeping the opening into the sac patent until it has healed up from the bottom.

The posterior variety is more difficult and dangerous to deal with. After the abdomen is opened the sac will usually be found to project markedly into the abdominal cavity under the peritoneum, and at first it may be thought to be a tubo-abdominal pregnancy. The abdominal cavity should be packed off, the sac incised, and the foetus extracted, care being taken not to allow any of the fluid contents, if

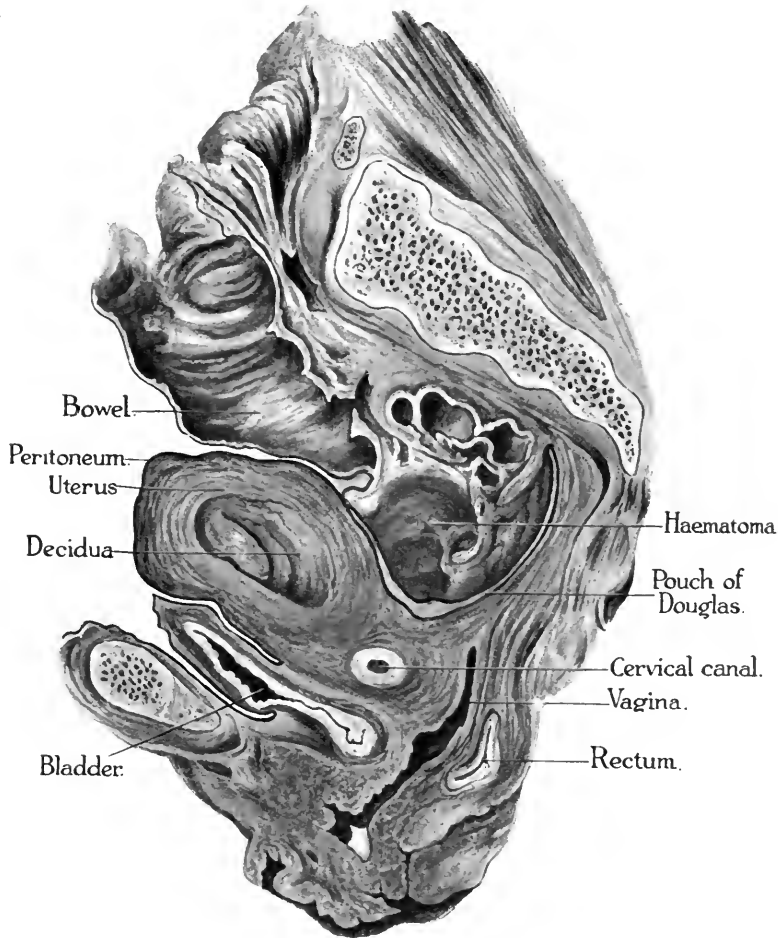


FIG. 238.—Intraligamentary pregnancy, lateral sagittal section *in situ*. The uterus is displaced laterally. (Berry Hart.)

possible, to escape into the general peritoneal cavity. The margins of the incision into the sac should then be sewn to the margins of the abdominal wound, and the sac plugged with iodoform gauze. If it is found impossible to draw the sac-wall up to the abdominal wall, the condition may be dealt with in the following ways. The sac may be plugged with gauze, brought out of the abdominal wound, and the peritoneal cavity shut off with other plugs passing down to the sac. Adhesions

will rapidly form round these, and they can be subsequently removed, leaving the opening into the sac shut off from the general peritoneal cavity. In a case in which the placenta is situated at the upper part of the sac, it may be possible to take the additional precaution of draining the sac through the posterior vaginal fornix with a gauze drain, so further diminishing the risk of infection of the peritoneum. At the end of three or four weeks an attempt should be made to remove the placenta, so as to minimize the risk of septic infection and shorten the period of convalescence.

The figures published by Sittner are of considerable interest. He has collected altogether 164 cases of coeliotomy in advanced extra-uterine pregnancy with a living child. During the period of twenty years covered by these statistics, marsupialization of the sac, the placenta being left behind, was attended by a mortality of 30·7 per cent, the removal of the placenta on the other hand, after securing the blood-vessels, by one of 6·8 per cent. During the years 1901–1906, marsupialization of the sac was attended by a mortality of 40 per cent, direct removal of the placenta with ligature of the blood-vessels by one of 12·5 per cent. His figures also show that when it was possible to remove not only the placenta, but also the sac, the mortality is only 5·7 per cent, as against a mortality of some 30 per cent when the sac was left behind after removal of the placenta. These figures are not, however, so convincing as they appear, when we remember that it is only possible to remove the whole sac together with the placenta in the simplest cases, those in which a low mortality is to be expected. They do, however, strengthen the view that the ideal treatment is the removal of the whole sac and placenta whenever possible, and as a general rule as soon as a diagnosis is made.¹

In discussing the operative treatment of cases of advanced ectopic gestation we have so far assumed that the child is alive and the placenta quick, with its circulation unimpaired. When the child is dead, the risk of any of these operations is much diminished, so much so that many operators prefer to wait until after the death of the child before interfering.

This waiting policy is attended with the dangers of septic changes taking place in the sac, or of a sudden acute and even fatal haemorrhage² occurring, or from rupture of the sac,³ or partial separation of the placenta before the vessels are completely thrombosed. The exact length of time which must be allowed to elapse before it

¹ A. Sittner, *Arch. f. Gyn.*, 1908, lxxxiv. 1.

² Horrocks has recorded a case in which the patient had been under observation for four months, and internal haemorrhage and collapse occurred at full term from accidental separation of a portion of the placenta; immediate operation was resorted to, but the patient died on the table (*Trans. Obst. Soc. Lond.*, 1894, xxxv. 180).

³ As in a case recorded by Spencer, the sac ruptured at seven and a half months, while the patient was lying in bed in the hospital (H. Spencer, *Trans. Obst. Soc. Lond.*, 1906, xlvii. 116).

is safe to operate is very uncertain. Cullingworth¹ has recorded a case in which, in as short a time as four weeks after the death of the foetus, the placenta was removed without any appreciable bleeding, while Berry Hart, in cases of subperitoneal pregnancy, recommends waiting only a few days. Litzmann endeavoured to determine the earliest time at which the placenta could be separated² without any danger of haemorrhage, but was unable to come to any definite conclusion. As a general rule, at the end of two months after the death of the child, the circulation through the placenta has ceased sufficiently to allow it to be removed without any danger of severe haemorrhage.

In cases in which a considerable interval of time has elapsed,³ and changes have occurred in the foetus, such as mummification, or the formation of a lithopaedion, the operation for its removal usually presents but few difficulties. This is particularly so when a lithopaedion is present, as no trace of the placenta is as a rule to be found. In these cases the sac of the pregnancy gradually shrinks and contracts, and ultimately may occupy a very circumscribed position, strikingly different from that which it occupied before the death of the foetus. Bland-Sutton has pointed out that in cases where the foetus has been converted into adipocere, parts of it, especially the hairy scalp, are very liable to be adherent to the walls of the sac.

While a number of retained foetuses remain quiescent, and may be carried about by a patient for many years without giving rise to any discomfort, in a certain proportion of the cases suppuration occurs (Fig. 239). This is most commonly seen in cases of posterior subperitoneal pregnancy, where the sac is in close relation to the rectum, and in which as a rule its extirpation is impossible. When we recall how, in this variety of pregnancy, the peritoneum is lifted away from the pouch of Douglas and the rectum, it is easy to see how readily infection can spread from the bowel to the contents of the sac. The anatomical relations, too, explain why suppuration is so much more common in posterior than in anterior subperitoneal pregnancies. When an abscess does form, it tends to point through the rectum, vagina, bladder, or abdominal wall. The patient will exhibit the symptoms of septic poisoning, viz. fever, a rapid pulse, emaciation, marked tenderness over the sac, distension of the abdomen, possible resonance over the tumour due to the presence of a gas-forming bacillus, tenesmus, and diarrhoea, produced either by the irritation of the bowel, or secondary to the septic absorption.⁴

¹ C. J. Cullingworth, *Trans. Obst. Soc. Lond.*, 1894, xxxv. 155.

² Litzmann, *Arch. f. Gyn.*, 1880, xvi. 397.

³ J. W. Bovée, *George Washington University Bulletin*, 1906, vol. v. No. 3, 30. This paper contains a very full account, with the literature, of retained ectopic foetuses.

⁴ A. Doran, *Trans. Obstet. Soc. Lond.*, 1901, xlii. 219.

As a general rule these abscesses should be treated whenever possible by an incision through the vagina, even if they have ruptured into the rectum, or by an extraperitoneal incision through the abdominal wall, as in a suppurative cellulitis pointing above Poupart's ligament. Cases such as that recorded by Sheild,¹ in which there was sloughing of the abdominal wall, and attempted extrusion of a putrid foetus near the umbilicus, are undoubtedly instances of suppurating anterior



FIG. 239.—Lithopaedion removed after death from the abdomen of a woman aged 76 in whom it had been retained 37 years. (Royal College of Surgeons Museum, No. 477.)

subperitoneal pregnancies, while the much commoner condition in which foetal bones are expelled through the rectum, are generally instances of the posterior type of subperitoneal pregnancy. It may be possible in such a case to extract the remains of the foetus, generally reduced to the bony skeleton, through the rectum, or it may be found better to practise a posterior colpotomy, and drain the abscess in that way as well (Fig. 240). In a case of my own, in which the patient presented

¹ M. Sheild, *Trans. Obst. Soc. Lond.*, 1892, xxxiii. 148.

an abdominal tumour behind the uterus, the size of a sixth-month pregnancy, eleven months had elapsed since the last period, and the foetus was extracted piecemeal through a large opening in the anterior rectal wall. If a pelvic abscess is found after the abdomen has been opened, it is best treated as has been stated, by closing the abdomen with or without drainage, after making a counter-opening through the posterior vaginal fornix. When an extra-uterine gestation-sac has suppurated, the formation of an opening into the vagina is, as Parry says one would suppose it to be, "one of the most favourable channels" for its discharge.

In removing the contents of a suppurating sac, either through the vagina, or through the rectum, the ease with which the upper boundaries of the sac may be damaged by rough manipulations must be remembered, as if they are torn the patient runs a very grave risk of septic peritonitis.

If, on the other hand, suppuration has not taken place, and the foetus is not disintegrated, an attempt

to deliver the child by the vagina in the later months of pregnancy is to be deprecated, and the abdominal route should always be chosen. The difficulties which may attend the delivery of the foetus through the vagina, are illustrated by a case recorded by Donald,¹ in which it was necessary to perforate and remove the vault of the skull in portions, before the foetus could be extracted.

The bursting of the suppurating sac of an extra-uterine gestation into the bladder is a most serious complication. If such an accident occurs the remains of the foetus can be extracted through the vagina by a colpoecystotomy, or through the abdominal wall by a suprapubic cystotomy. Occasionally it has been found possible to remove small disintegrated portions of foetal remains through the dilated urethra.

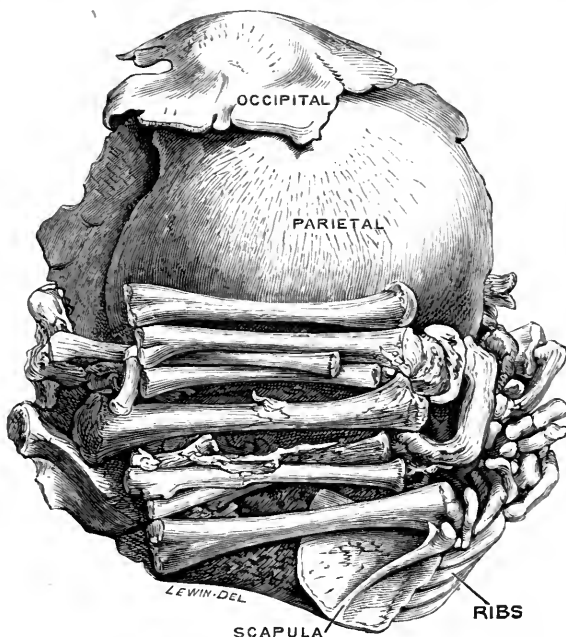
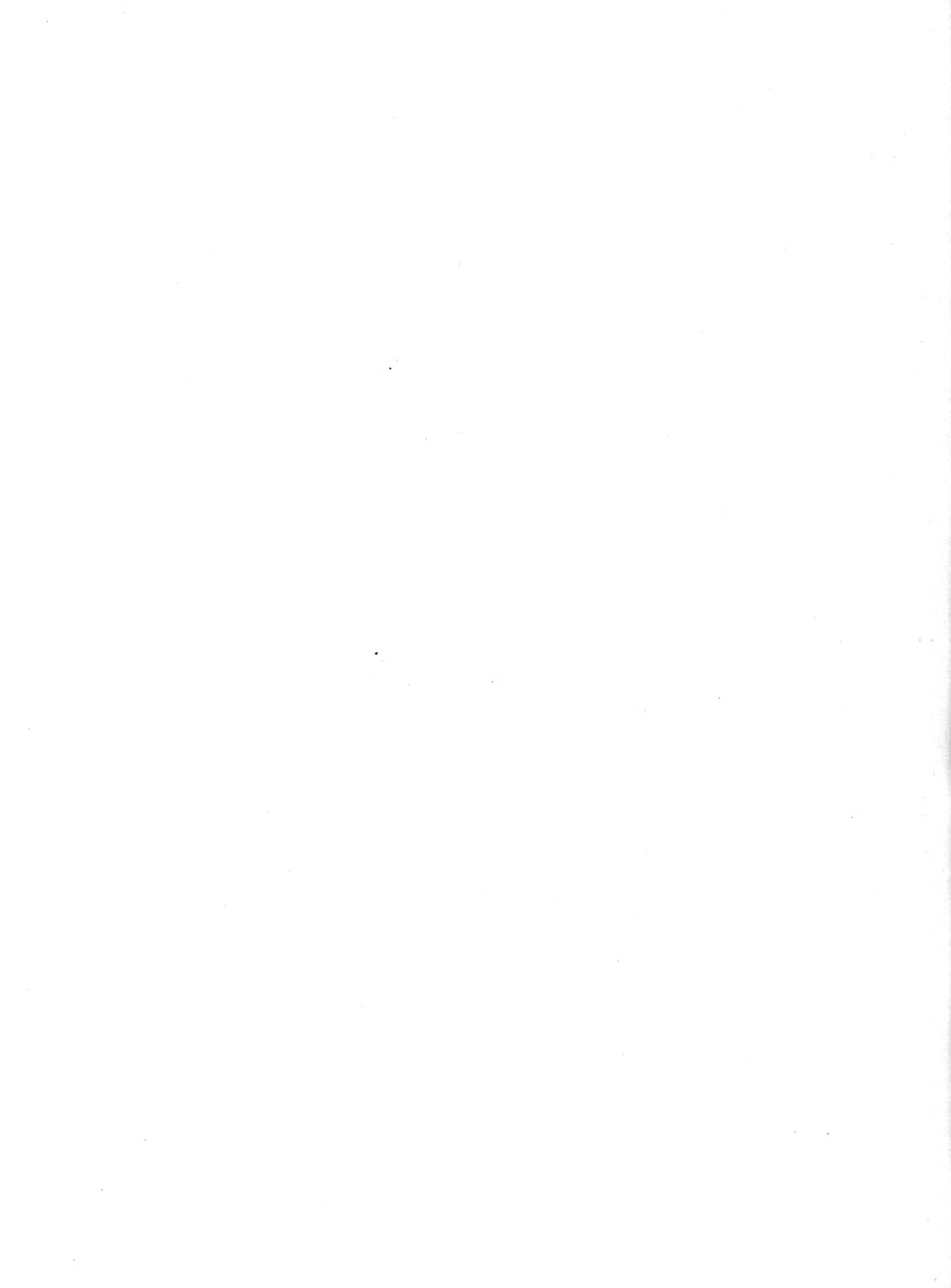


FIG. 240.—Mass of foetal bones from a case of tubal pregnancy. (Bland-Sutton.)

¹ A. Donald, *Trans. Obst. Soc. Lond.*, 1900, xli. 7.



PELVIC INFECTIONS

In this section the following subjects are dealt with :—

SEPTIC INFECTIONS

GONORRHOEA IN WOMEN

TUBERCULOSIS OF THE FEMALE GENERATIVE ORGANS

INFLAMMATORY AFFECTIONS OF THE FALLOPIAN TUBES

PELVIC CELLULITIS

SYPHILIS IN WOMEN

STREPTOTHRIX INFECTIONS OF THE PELVIS

ECCHINOCOCCAL INVASIONS OF THE PELVIS

SEPTIC INFECTIONS

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General Considerations.—Strictly speaking, all infections by bacteria are *septic*, just as the methods adopted to prevent infection are termed *aseptic*. In this section, however, only those conditions will be described which are due to infection by the common pus-forming organisms, the word *septic* being used in its limited and conventional sense. The reader will find in other parts of this work full accounts of the infections by the specific organisms of the venereal diseases, of tubercle, and of actinomycosis.

Of the organic diseases found in the wards of Hospitals for Diseases of Women, infections are probably the commonest conditions. Lea¹ says that one-third are of this character. Although the gonococcus is the most frequent intruder, the non-specific pyogenic organisms rank next in frequency either as primary infections, or as secondary to one of the specific infections. The commonest occasions when septic infection takes place are during labour or abortion, and the first two or three days of the puerperium. In addition to these puerperal cases many septic infections develop after manipulations and operations on the pelvic organs, notably curettage and the passage of the uterine sound. Another form of septic infection requires to be mentioned here, although dealt with elsewhere, *i.e.* infection of pelvic new growths, notably cancer of the cervix and submucous fibroids.

Classification.—The septic infections arising in connection with labour and abortion present distinctive features, chiefly on account of the altered anatomical conditions and relationships of the generative organs resulting from pregnancy, and they will be described separately from the much less frequent and less serious infections which arise apart from pregnancy.

¹ *Puerperal Infection*, by Arnold Lea, p. 21.

Accordingly septic infections of the female generative organs may be classified into : (1) puerperal infections ; (2) non-puerperal infections.

PUERPERAL SEPTIC INFECTIONS

Definition.—*Pyrexia* occurring after labour or abortion is usually regarded as evidence of infection unless the pyrexia can be attributed to some other definite cause. Exactly what degree of temperature may be called pyrexia is a matter of opinion, and different standards of morbidity are adopted by various hospitals and authorities. The standard recommended by the British Medical Association is reasonable and moderate, and might with advantage be generally adopted. It is as follows : “The puerperal morbidity should include all fatal cases, and also all cases in which the temperature exceeds 100° F. on any two of the bi-daily readings from the end of the first to the eighth day after delivery.”

Frequency.—Lea ¹ concludes after an exhaustive investigation of statistics that the *morbidity* in hospitals is between 10 and 20 per cent, varying according to the method of estimation. No doubt a considerable proportion of these cases are temporary elevations of temperature due to causes other than infection, and of the infected cases a large number are of a trivial nature. Severe cases of septic infection rarely develop in Lying-in Hospitals, such cases as do occur having usually been infected previous to admission.

In Lying-in Hospitals puerperal mortality due to septic infection has been reduced to 0.1 or 0.2 per cent.² It is clearly impossible to estimate the frequency of and mortality from puerperal infection in private practice because the cases are not always reported, but they are probably greater than in hospital practice and greater than most practitioners imagine them to be.

History.—The history of the septic infections of the female genital organs forms an interesting chapter in medicine. It is worthy of remark that long before Lister's time, obstetricians realized that puerperal fever was a wound infection, that the disease was conveyed almost always from without, *i.e.* by the examining finger of the person attending the labour, and that the disease could be prevented by the disinfection of the hands, instruments, and dressings with chlorine water.

The condition has probably been recognized from time immemorial, and the earliest medical writers refer to it, notably Hippocrates, Celsus, Galen, and Avicenna. In the sixteenth century Mercutus, Ambrose Paré, and Plater wrote about it. Plater showed that the disease was essentially an inflammation of the womb, and later,

¹ *Loc. cit.* p. 37.

² *Loc. cit.* p. 37.

in 1676, Willis (who first used the term *puerperal fever*) wrote in support of the old theory of the retention of the lochia being the cause of the disease.

In 1686 Puzos elaborated the theory of milk metastasis. This was long in vogue, strengthened as it was by the observations of Col de Villars and Fontaine, who found a fluid resembling milk in the abdomen of women dying of this disease.

In the eighteenth century Denman, Smellie, William Hunter, and Kirkland mentioned peritonitis as an essential feature of the disease, and Kirkland, writing in 1774, described its contagiousness. The epidemics of puerperal fever in Paris, London, Edinburgh, and Dublin, in the middle of the eighteenth century led to a common belief in the infectious nature of puerperal fever, but it remained for Gordon of Aberdeen in 1795 clearly to demonstrate that the disease was carried by medical men and nurses from one case to another.

During the next half-century puerperal fever was regarded as a specific disease, and in 1843 there appeared the classical essay of Oliver Wendell Holmes proving the infectious nature of the disease.

No name is more outstanding in this connection than that of Semmelweis. In 1846 he found that the mortality of labour cases attended by medical students, who were also engaged in *post-mortem* work and dissecting, was four times greater than in those attended by midwives. He further observed that the *post-mortem* appearances in the body of a colleague who had died from a *post-mortem* wound, resembled those of women who had died of puerperal fever. From these observations he concluded that the morbid process in puerperal fever was a wound infection due to the introduction of "cadaveric poison" by the examining finger. By insisting on the washing and disinfection of the hands of students in attendance at labours, he showed that puerperal fever could be prevented, and actually reduced the death rate in the maternity hospital from this cause from 11 to 1 per cent.

The name *puerperal septicaemia* was first applied to the disease by Tarnier in 1857, because he considered it a form of blood poisoning. Pasteur's work in 1860-63, followed by Lister's communication on "The Antiseptic Principle in the Practice of Surgery," led to the recognition of the truth, that puerperal fever was due to wound infection by micro-organisms.

It is of interest to gynaecologists to know that the true nature of wound infection was foreshadowed by Semmelweis, and that washing and disinfection of hands for its prevention was actually carried out twenty years before Lister's paper appeared.

Pathological Anatomy of Puerperal Infection

Knowledge on this subject has been gained mainly from *post-mortem* observations, but during recent years the appearances during life and in less advanced stages have been revealed by operative interference and examination of specimens removed by operation. It is remarkable how frequently the generative organs appear to be normal although the patient may be extremely ill, or may have actually died of infection commencing in these organs. In some such cases the infection has become general without meeting with much local resistance, and in others the local disease has cleared up while its extensions remain, notably infections of the peritoneum, the large veins, and the lungs. In most cases, however, gross changes are found, and these will be described in anatomical order.

Vulva.—Infected wounds here present the same appearance as septic wounds elsewhere. In severe cases of septic infection they are often of a dirty greenish-yellow colour, bathed in foul, purulent discharge and called *puerperal ulcers*. They are most commonly seen at the posterior part of the introitus.

Vagina.—Septic wounds after instrumental delivery are common and are chiefly extensions of wounds of the perineum or cervix. As a rule the infection remains quite localized. Large necrotic areas may be seen occasionally after prolonged labour, and vesico-vaginal fistula and stenosis may follow this lesion. Rupture of the vagina with involvement of cellular tissues, peritoneum, or bladder are the most serious lesions, though happily rare. They may be detected for the first time during an investigation into the situation of an infection. A general superficial vaginitis with much purulent discharge is common. It may be caused by the irritation of septic discharges from the uterus, and is often associated with a chronic gonorrhoeal infection, exalted in virulence by the septic infection.

Cervix Uteri.—The cervix usually has a normal puerperal appearance but often lacerations are found, and these may be connected with inflammatory masses of varying size in the paracervical connective tissues. Sloughing ulcers may be seen in the severe forms of the disease.

Corpus Uteri.—The appearances of this part and more particularly of its cavity are of paramount importance, for the primary seat of infection is usually here, and the infection is often limited to the uterus. The size of the uterus varies with the date of the puerperium; it is usually a little larger, and occasionally much larger, than the normal puerperal uterus. Its external surface may be roughened from fibrinous deposit, but as a rule only when the peritoneum over neighbouring structures is also involved. When examined *in situ* during life it is soft and easily lacerated.

PLATE X. Vol. I



Uterus removed *post-mortem* from a case of puerperal fever. Endometrium is necrotic and ulcerated.
At fundus is attached a piece of placenta covered with blood clot.

The cavity of the uterus is usually strikingly free from abnormal features. Occasionally it contains decomposing blood-clot, fragments of membranes or placenta, with foul-smelling purulent discharge and a thickened, even polypoid, and sloughing endometrium (Plate X.). This is the "putrid puerperal endometritis"¹ of Bumm, and is found in cases clinically called *sapraemia*. The much commoner variety of uterine infection where the macroscopic appearances are practically normal is known as "septic" or "infective endometritis," and corresponds to the clinical form of the disease known as *septicaemia* (Fig. 241). The organ is bulky in the former variety, while in the latter it is rarely enlarged. The microscopic appearances of the two varieties are also distinctive. In the *putrid* variety under a thick necrotic layer lies a wide protective wall of leucocytes, and in the *infective* variety there is a narrow necrotic layer and an ill-formed wall of leucocytes (Figs. 242 and 243). In the latter case organisms penetrate the mesometrium while in the former they are effectually walled off. These differences satisfactorily account for the greater severity of the symptoms and greater danger of the disease in "infective endometritis" or *septicaemia* than in "putrid endometritis" or *sapraemia*.



FIG. 241.—Uterus removed by operation for 'puerperal infective endometritis.' The endometrium is thrown into folds, but its surface is smooth.

While these types are very distinctive, combinations often occur, especially in consequence of intra-uterine treatment; e.g. after curettage the "putrid" form is liable to become "infective."

The differences in appearance, macroscopic and microscopic, between putrid and infective endometritis, are largely determined by the form and virulence of the organisms producing the disease. In putrid endometritis saprophytic organisms, bacilli of the coliform group especially, are found in the cavity of the uterus,²

¹ *Archiv für Geb. und Gyn.*, 1891, Bd. xi.

² See Article on Micro-Organisms in the Female Genito-Urinary Tract (p. 97).—EDITORS.

and in infective endometritis streptococci can usually be detected in the endometrium and the uterine wall.

The *musculature* of the uterus rarely shows naked-eye appearances of inflammation, although in streptococcal infections deep and extensive infiltration may occur, and occasionally abscesses, either multiple or single, may result (Fig. 244 and Plate XI.). Very occasionally a portion of uterine wall becomes gangrenous,

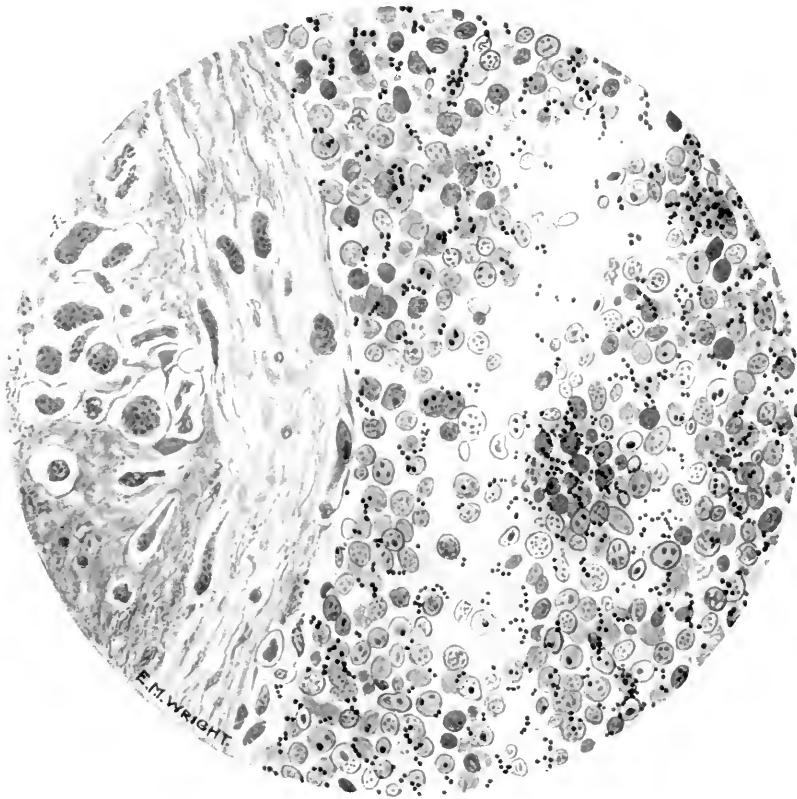


FIG. 242.—Acute endometritis with well-developed leucocytic protective zone, thrombi in decidua vessels. Typical appearance of 'putrid endometritis.' ($\times 150$.) (Arnold Lea.)

and is discharged in fragments with offensive odour two or three weeks after delivery. This has been called *metritis desiccans*.

The *venous sinuses* of the uterine wall (Fig. 242), more particularly those under the placental site, are often infected, hence the frequency of the infection of the ovarian and uterine veins.

At the risk of repetition the important fact may here be pointed out that in



Streptococci in a microscopic abscess-cavity in the muscular wall of the uterus ;
from a fatal case of septic puerperal endometritis.

infective conditions originating in the genital tract the uterus and even all the generative organs may be quite or almost free from demonstrable inflammatory lesions.

Pelvic Cellular Tissue.—Infection extends to this tissue through lacerations of the cervix and occasionally from the cavity of the uterus. This lesion is fully described in the Article on Pelvic Cellulitis (p. 649), to which the reader is referred.



FIG. 243.—Acute infective endometritis. Streptococcal infection. Imperfectly developed zone of leucocytes. ($\times 150$.) (Arnold Lea.)

Peritoneum, Tubes, and Ovaries.—Peritonitis, general or limited to the pelvis, is often found *post mortem* in fatal cases of septic infection. The infection spreads either along the tubes or directly through the wall of the uterus, the latter being the usual route. A limited degree of peritonitis always accompanies infection of the tubes and ovaries, and sometimes of the uterus and of the cellular tissues. *The tubes and ovaries* are often involved in the spread of infection and occasionally

pyosalpinx and ovarian abscess are found. These mostly develop after an interval in cases of gonorrhoeal infection. The ovaries and tubes in general peritonitis may be non-adherent, and may show no more signs of inflammatory reaction than the other viscera.

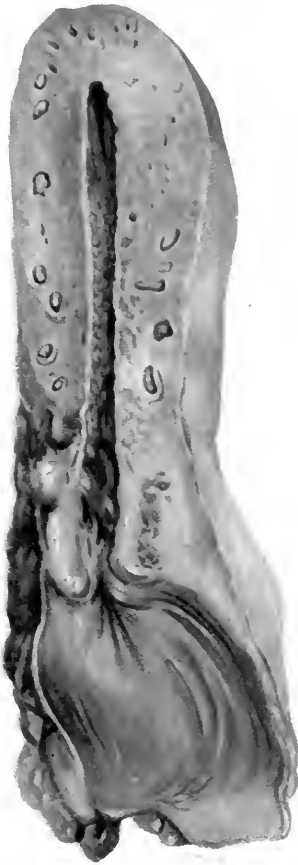
The Large Veins.—The large uterine sinuses normally thrombosed after labour, become infected either directly or by extension from the endometrium. From



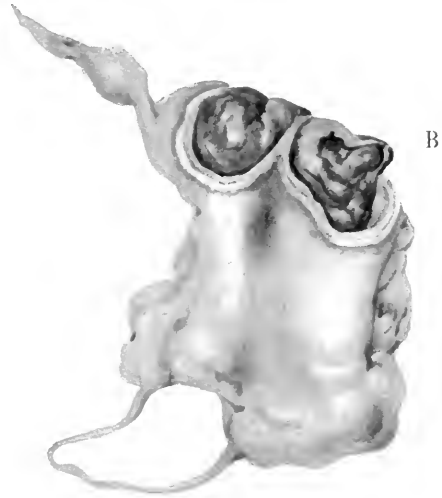
FIG. 244.—Section of myometrium from fatal case of septic endometritis. The muscle shows small-celled infiltration and a microscopic abscess-cavity (A).

them infection readily travels to the ovarian and uterine veins, preceded by a progressive thrombosis, and in turn the iliac veins, and even the vena cava, may become involved. (See Plate XII.) In virulent infection the thrombosed vein often suppurates, and emboli from it may infect the lungs, pleurae, and endocardium.

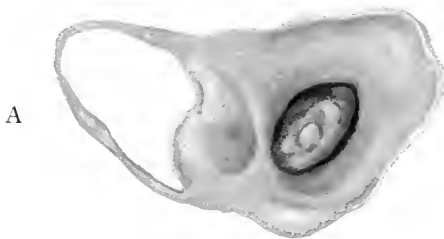
The accompanying *lymphatics* are usually implicated, and periphlebitis with abscess formation may result from extension of the infection through the wall of the vein.



Specimen of septic thrombosis of uterine venous sinuses removed *post mortem* from a case of puerperal pyaemia six weeks after delivery.



B



A



C

Large pelvic veins resected for thrombo-phlebitic pyaemia : clot decomposing with offensive smell.

- A. Clot in right common iliac vein projecting into stump of inferior vena cava. Ring of tissue is portion of left common iliac vein.
- B. Same Specimen seen from behind : clot projecting from upper ends of internal and external iliac veins.
- C. Right common iliac vein and portion of external iliac vein laid open : ring of left common iliac vein.

Thrombo-phlebitis of the *femoral vein* is common, usually of streptococcal origin, and due to extension of infection from the uterus through the uterine and iliac veins. Oedema of the affected limb, which usually accompanies this lesion, varies considerably in degree and extent. The amount and distribution of the oedema depend mostly upon the length of the vein involved, and the freedom of the collateral venous circulation, but probably to some extent also upon the amount of lymphatic obstruction caused by the accompanying periphlebitis.

Symptoms of Puerperal Infection

While no doubt the severity of the symptoms of the disease depends to a great extent on the variety and virulence of the organism or organisms, it is certain that they also vary considerably with the site of the infection ; lesions of the vulva and vagina usually produce the least serious forms of the disease and uterine infections the most serious. In the *early* stages, however, there may be little difference between the symptoms of uterine and vulvo-vaginal infections. The latter produce lesions and symptoms resembling those of surface wounds elsewhere.

During the progress of the disease by extension of the infection from the uterus, various other structures may be involved producing definite physical signs and characteristic features. For convenience of description these secondary clinical varieties will be discussed separately although more than one variety may occur, successively or concurrently, in the same case. It must be remembered that the primary infection is usually confined to the uterus and that in nearly all the secondary varieties the uterus is or has been infected.

Symptoms of Uterine Infection.—They commence as a rule within the first few days after labour, and are chiefly those which ordinarily accompany an elevated temperature, viz. malaise, headache, and feelings of chilliness, or even a definite rigor. The temperature rises to 100° or more, and the pulse is usually accelerated to 100 or more per minute. The secretions are lessened, notably the milk, saliva, and urine. The higher and more continuous the temperature, the more marked are these symptoms. Rashes, sleeplessness, intellectual dulness, diarrhoea, and vomiting may occur.

On physical examination nothing abnormal may be observed except perhaps a little tenderness of the uterus. At the vulva and in the vagina, scanty discharge or even dryness may be noticed. Offensive odour, contrary to the belief too commonly entertained, is usually absent ; puerperal ulcers do not appear at first, but may be seen after a few days in the severe forms of the disease.

It is customary to classify cases of puerperal uterine infection into two types,

sapraemia and *septicaemia*, which correspond to the pathological varieties "putrid endometritis" and "infective endometritis" described on p. 529. This distinction is valuable, because the physical signs of sapraemia are usually definite, viz. enlarged uterus and profuse offensive discharge, and the indications for its treatment are clear and definite.

Sapraemia occurs mostly after abortion and premature labour, and there is usually a history of some intra-uterine manipulations or of incomplete removal of the placenta and membranes. It seldom occurs after full-term labour unless the slight and temporary rise of temperature unaccompanied by symptoms, which may often be noticed after labour, is of this nature. In sapraemia the general condition usually suffers only to a slight extent, and the temperature as a rule is not very high.

Septicaemia is a more serious disease, and is as a rule attended by more marked symptoms than sapraemia. Though not invariable, an initial rigor occurs in the majority of cases. The patient looks ill, and the pyrexia, generally speaking, is higher than in sapraemia. *The pulse-rate is always rapid*, and is to a great extent independent of the temperature. By contrast, in sapraemia the pulse-rate varies proportionately with the temperature; it is seldom rapid, and may be normal in frequency and volume when the pyrexia is low.

The course of the disease varies considerably. In the less severe types of *septicaemia* the temperature usually subsides in a week or ten days, the pulse a few days later, and the patient makes a complete recovery. The more severe types are not as a rule more prolonged but oftener end fatally, either from the severity of the toxaemia alone or from complications, such as general peritonitis or puerperal pyaemia. *Sapraemia* usually runs a short course, unless there is delay in carrying out the appropriate treatment. After clearing out the uterus the temperature promptly returns to normal, and the patient is soon quite well. If this local treatment is not adopted or is incomplete, the symptoms usually get worse, and sapraemia may be transformed into septicaemia.

Unfortunately it sometimes happens that cases which have the clinical features of sapraemia do not respond to local treatment as expected, and after evacuation of the uterus the temperature rises, the pulse gets quicker, and the general condition of the patient grows worse. It is more apt to occur when the patient has a more rapid pulse and more severe general symptoms than is usual in cases of definite sapraemia; it is also commoner after labour than after abortion. The explanation of such a sequence may be either that the saprophytic organisms have become pathogenic, and have colonized the uterine wall through the raw areas produced by the intra-uterine manipulations, or that the original condition was not merely a

sapraemia but a combined sapraemia and septicaemia. Probably both explanations operate, in some cases the one and sometimes the other.

Symptoms of Extra-Uterine Infection.—Quite commonly the infection travels beyond the uterus, producing marked and definite lesions, the signs and symptoms of which vary according to the organ or structure involved. The chief lesions produced are pelvic cellulitis, salpingo-oöphoritis, pelvic peritonitis, general peritonitis, and venous infection.

The symptoms produced by the two first-named conditions are fully described in the Articles devoted to these subjects.

Pelvic Peritonitis.—Extension of the infection to the lower part of the peritoneal cavity is accompanied by pain and tenderness in the lower abdomen which is distended, by raised temperature and pulse-rate, and by vomiting. Although most frequently of gonorrhoeal origin and associated with salpingo-oöphoritis, it occasionally results from *septic* infection, severe trauma, especially rupture of uterus or vagina, predisposing to its occurrence. Being a terminal affection it may escape notice, or it may produce acute and severe symptoms early in the course of the disease, or may run a subacute course with exacerbations. Pus usually forms and points, if not previously evacuated, in the posterior fornix of the vagina, in the rectum, or in the bladder.

General Peritonitis.—This complication of septic infection of the pelvic organs claims attention on account of its seriousness, and from the fact that it is seldom diagnosed or treated until the patient is beyond hope of recovery. It may develop at any time during the puerperium, but usually during the second week, and after a few days' illness with pyrexia. The onset may be sudden and severe and accompanied by pain, vomiting, and sometimes a rigor; more often it is less acute and even indefinite, its symptoms being obscured by the general toxæmia due to the primary infection in the uterus. The pulse is always quickened from the first to 110 or 120 per minute; its tension may be good for a day or so, but as the rapidity increases to 130 or more, it becomes soft and small, and towards the end irregular and uncountable. Pyrexia may be absent, but as a rule the temperature rises to 101° or 102° or higher, and is characterized by remissions. Pain is one of the earliest and most constant symptoms, although in some cases it may not be marked, and towards the end it disappears. The pain is general, but is most severe in the lower abdomen and about the umbilicus. Epigastric pain denotes extension to the region of the diaphragm.

Vomiting and retching usually mark the onset of general peritonitis, and attacks of sickness may recur, becoming frequent and troublesome towards the end. At

first the stomach contents are brought up, then bile-stained fluid, and later the vomit has reddish-brown flakes in suspension—an ominous sign. In the early stages the bowels are not moved, but after repeated administration of purgatives and enemata diarrhoea, which may become intractable and exhausting, sets in and it often recurs as a terminal trouble. Recurrent obstruction of the bowels may occur, particularly in cases of gonorrhoeal origin.

Tenderness, muscular rigidity, and limitation of the respiratory movements of the abdominal wall, which form such striking features in general peritonitis due to perforation of appendix, duodenum, stomach, etc., are often notably inconspicuous in general peritonitis of puerperal origin. These signs may even be absent altogether in advanced cases. Distension is usual, and may become so extreme as to cause dyspnoea. Fluid in the peritoneum, although it may be present in quantity, is not readily detected by physical examination, owing to gaseous distension of the bowel.

The patient's aspect is significant. At first absence of repose and even restlessness strike the observer. The face is flushed, and wears an expression indicative of pain or even agony. The disquieting symptoms then subside, and a deceptive calm reigns for a day or two, to be followed by increased frequency of pulse, vomiting and diarrhoea, cold extremities—signs of the approaching end.

The course of general peritonitis varies. The disease usually lasts 5 or 6 days; sometimes it is rapidly fatal, and sometimes life is remarkably prolonged. Cases associated with a gonorrhoeal infection often run an intermittent course; they are the least acute, and in some instances recover, although the peritonitis appears to be diffuse. Those of definitely septic origin, especially when associated with severe traumatism of the pelvic organs, run the most rapid and severe course. A particularly severe and rapidly fatal type, called *acute peritoneal septicaemia*, results from infection by virulent streptococci. The source of the infection in this type can usually be traced to another case of sepsis, surgical or otherwise.

Infection of the Veins.—The results of extension of the disease from the uterus to the main venous trunks of the pelvis are vastly different from one another in their clinical aspects. The two chief types of this complication are: (a) thrombosis of femoral veins; (b) puerperal pyaemia (thrombo-phlebitic pyaemia). The former is characterized by oedematous swelling of one or both lower limbs without severe constitutional disturbances; in the latter multiple septic emboli are deposited in distant parts, and repeated rigors occur, with a grave, usually fatal toxæmia. The marked difference between these two types depends to some extent on the vein or veins affected, and also, most probably to a greater extent, on the organism or organisms concerned.

Besides these two types, cases are occasionally met with which have some of the leading features of both. During the course of these types of septic infection changes and fluctuations may and often do occur in both their obstructive and toxæmic features. A case with mostly obstructive signs may become markedly toxæmic, and a toxæmic case may settle down into the safer thrombotic variety.

(a) *Thrombosis of Femoral Veins*.—The onset is usually sudden during the second week of the puerperium, and is characterized by increase or recurrence of pyrexia, pain in the limb affected, and oedema which may commence at the foot or in the groin. The pain and temperature gradually subside in a week or ten days. The left limb is more commonly affected than the right, but in one-third of the cases both limbs suffer. Fulness, induration, and tenderness at some situation along the course of the main vein of the limb may be found, usually in the groin.

The disease as a rule runs a favourable course; first the pain disappears, and then more gradually the swelling subsides. Oedema of the foot, also tenderness and swelling along a portion of the main vein, may persist for a while. Oedema of the foot and leg may be troublesome for months. Occasionally the thrombosis is limited to a superficial vein or the posterior tibial veins when the oedema may be slight or absent.

(b) *Puerperal Pyæmia*.—This form of venous infection is by no means rare. Lea concludes that it is responsible for from 30 to 50 per cent of all deaths from infection. In nearly all cases intra-uterine manipulations have preceded its onset, *e.g.* careless treatment of placenta prævia and puerperal hæmorrhage. In many cases the operation of curettage, for uterine infection, has recently been done.

Clinically the condition is characterized by repeated rigors. Between the rigors the temperature may subside, but as a rule there is marked pyrexia. Sweating is common; a slight cough and some pleuritic pain often follow a rigor, and are due to pulmonary infarction. When the cough, though slight, persists, pulmonary infarction is probable. There is seldom much sputum. Anaemia and wasting rapidly develop. In the intervals between the rigors when the temperature is down, the patient may feel and look fairly well, and be able to take food and sleep well. Although no part of the body is exempt from infected emboli, they rarely pass into the systemic circulation,

The physical signs are often slight or even negative. The abdomen is usually distended, and slight tenderness over the course of the ovarian or external iliac veins may be detected. Vaginal examination may reveal, by careful palpation, a small, slightly tender swelling either high up in the ovarian region due to phlebitis of the ovarian plexus of veins, or at the base of the broad ligament when the uterine

veins are thrombosed. The pelvic wall sometimes feels as if a thin smooth layer of cement has been plastered on it. This is due to periphlebitis of the internal iliac vein. Signs of ulcerative endocarditis may be made out, and half the fatal cases are said to show this complication. Septic broncho-pneumonia, usually found *post mortem*, has seldom been detected during life, although the chest may have been carefully examined.

The course of the disease may be prolonged; occasionally it is cut short by sudden death from pulmonary embolism. Usually death occurs in three or four weeks from a general asthenic toxæmia. An occasional case recovers after a severe illness and long convalescence, during which periphlebitic abscesses may point in the buttock or the loin.

Diagnosis of Puerperal Infection

“ All cases in which the temperature exceeds 100° F. on any two of the bi-daily readings from the first to the eighth day ” after labour or abortion, should be regarded *a priori* as cases of infection. In order to make a complete diagnosis it is necessary to answer the three following questions :—

- (1) *Is the case one of puerperal infection ?*
- (2) *What is the site and extent of the infection ?*
- (3) *What is the offending organism ?*

- (1) *Is the case one of puerperal infection ?*

An examination of the breasts, and of any region to which symptoms may be referred, with a general survey of the patient, will as a rule quickly settle this question.

Constipation may occasionally cause a slight pyrexia, but it is of short duration, and settles promptly after the bowels have been moved by the help of an enema or purgative. *Emotional excitement* sometimes produces a rapid pulse with slight rise of temperature, but the latter is of a fleeting character, and the practitioner may safely exclude this cause when he finds a temperature of 100° or more both morning and evening. *Influenza* is a diagnosis sometimes made in these cases, but it should be deliberately avoided in the absence of the concomitant symptoms of influenza, and a definite history of exposure to infection from another case of the same disease.

Pyelitis, resulting from infection of the urinary passages with organisms of the bacillus coli group, occurs frequently during the latter half of pregnancy and sometimes after labour or abortion. It can as a rule be readily detected, its chief features being tenderness of the kidney, more frequently on the right side, a palpable and tender ureter in the vaginal fornix, and the presence of pus in the urine. Catheter specimens only of the urine should be taken, and centrifugalized deposits examined

for pus under the microscope, although not infrequently a copious deposit on standing can be observed in the specimen glass.

Unless it can be clearly demonstrated that some other lesion is responsible for the pyrexia the diagnosis of puerperal infection should be made. It seems desirable to point out that patients who are seriously ill from puerperal infection tolerate any disturbance badly, so that in investigating such cases few questions should be put, and the physical examination should be carried out expeditiously, and with as little discomfort to the patient as possible.

(2) *What is the site and extent of the infection?*

A careful and complete physical examination will, generally speaking, lead to the determination of this important point. All forms of puerperal sepsis, except when the infection is limited to the uterus, have striking clinical features, and can be recognized from their positive physical signs. Accordingly, when investigating cases of this disease the most practical procedure is first to search for vulvo-vaginal lesions, cellulitis, peritonitis, and venous infections. In the absence of these conditions it is safe to diagnose a *uterine infection*. Thus the diagnosis of the common form of puerperal septic infection, *i.e.* when the infection is limited to the uterus, is made by first excluding the presence of the other forms of the disease. In most cases there are no confirmatory signs or symptoms; but frequently enough the uterus is tender, and sometimes it is larger than normal for the date of the puerperium, but this enlargement is not easily made out when the uterus is tender. To carry the diagnosis further and say to which variety, septicaemia or sapraemia, a particular case belongs, is not always possible, although very desirable for purposes of prognosis and treatment.

Sapraemia has definite physical signs, and can usually be recognized by them, but its diagnosis is not established unless decomposing material is found in the uterus and the symptoms promptly subside after the uterus has been cleared out.

Septicaemia produces severe general symptoms, a more rapid pulse, and usually a higher temperature than sapraemia, but no characteristic signs. Indeed, with the exception of some tenderness of the uterus, which is often absent, the physical signs are negative.

Cases are not uncommonly met with, in which the physical signs of sapraemia, *viz.* enlarged uterus and profuse offensive discharge, are associated with the more rapid pulse and severe general symptoms of septicaemia. There is usually also a history of intra-uterine interference and of some placental tissue being left behind. Such cases are most probably combined septicaemia and sapraemia, and the results of local treatment support this view, for the symptoms do not respond to evacuation

of the uterus as quickly as they do in ordinary cases of sapraemia. Sometimes the symptoms actually become worse after intra-uterine interference, resembling those of severe septicaemia or pyaemia, and a fatal issue may result.

It is therefore advisable, for purposes of prognosis, to regard all cases of uterine infection as septicaemia unless they have the definite signs and symptoms of sapraemia, and promptly respond to local treatment.

Infected wounds of the vulva and vagina are very common, and will be found if they are looked for. The patient should be so placed that a good view of the vulva can be obtained. If there are sutures in the perineum they should be removed. An infected wound will then readily open out, and any pent-up pus escape. Moreover, the examination of the vagina will be facilitated. This should be made digitally first of all, and by inspection through a duckbill speculum afterwards. Attention should be directed towards finding septic wounds and foci of suppuration. When inflammatory lesions of the vulva and vagina pass unrecognized the patient's recovery may be considerably delayed. If the case is regarded, in error, as one of septicaemia or sapraemia and local treatment is applied to the uterine cavity, the results may be serious on account of infection being carried by the manipulations from the septic vagina to the healthy uterus.

Venous infection can usually be diagnosed with certainty from its distinctive clinical features.

The *pyaemic* variety may be simulated by septicaemia in the early stages of puerperal infection, and in chronic cases the complications of pyaemia such as chest and kidney infections may obscure the primary lesion. Occasionally in septicaemia an initial rigor may recur once or even twice, and therefore before making a diagnosis of pyaemia it is advisable to wait until the patient has had three or four rigors, more especially in the early days of the infection. In doubtful cases the presence of a recently developed chest lesion points strongly to pyaemia. If on bi-manual examination tender and infiltrated areas can be detected in the position of the uterine, internal iliac, or ovarian veins the diagnosis of pyaemia can be made with confidence. When cases are seen in their late or chronic stages, pelvic abscess, septic bronchopneumonia, or other metastatic foci may dominate the clinical picture and obscure the primary lesion. The history of repeated rigors will usually clear up the difficulty in such cases, and often the pelvic examination will furnish evidence suggestive of venous infection. Rigors vary considerably in the severity and duration of the shivering, the accompanying pyrexia and the subsequent sweating. As a rule a rigor is quite definite enough, but it is advisable not to overlook attacks of chilliness with slight pyrexia, especially if followed by profuse sweating. Organisms can

sometimes be found in the blood after a rigor, but in cases with infrequent rigors, where help in diagnosis from such a source would be useful, organisms can seldom be found. Examination of catheter specimens of the urine may, however, in such cases yield positive results. If pus as well as organisms are found in the urine, meta-static infection of the kidney is probable.

Femoral thrombo-phlebitis can be readily diagnosed on ordinary surgical lines by swelling and tenderness somewhere along the course of the main vein of the limb, usually in the groin, and finding oedema of part or the whole of the limb. Aseptic thrombosis which occurs sometimes, differs from the infective form by the absence of pyrexia, although the pulse may be rapid; and often the condition may have existed previous to labour.

In this connection the terms *phlegmasia alba dolens* and white leg are commonly used, but variously and somewhat loosely. Some writers¹ apply the terms synonymously with thrombosis, others reserve the terms for a special and rare form of oedematous swelling in which the limb is greatly enlarged, white, very painful, resistant to pressure by the finger instead of pitting like the oedema of ordinary thrombosis, and said to be due to *lymphatic* obstruction. Most writers,² however, use the terms in respect to both the above conditions, and describe a venous and a lymphatic phlegmasia. That the ordinary form of the disease is a thrombo-phlebitis cannot be doubted. It was demonstrated as early as 1817³ and the thrombosis traced backwards to the uterine veins.⁴ That periphlebitis usually accompanies thrombo-phlebitis is capable of everyday verification by clinical observations of positive physical signs. Further, periphlebitis is often encountered during operations for the pyaemic form of venous infection, and the obstruction of the peri-vascular lymphatics can be demonstrated under the microscope in resected segments of the ovarian vessels.

Whether thrombosis of lymphatics alone, apart from phlebitis, is the cause of the extreme and rare form of oedema known as lymphatic phlegmasia is open to doubt. It is admitted that lymphatic phlegmasia is usually accompanied by venous thrombosis and is often clinically indistinguishable from thrombo-phlebitis.⁵ The probable explanation of the condition known as lymphatic or true phlegmasia is that the obstruction of both veins and lymphatics is more nearly complete than in the ordinary forms of thrombo-phlebitis, and the effusion of fluid into the tissues of the limb is consequently greater. In any case it seems undesirable to retain the

¹ Whitridge Williams, *Obst.* p. 798.

² Eden, *Manual of Midwifery*, 4th ed. p. 536.

³ By David Davis (*Med. Chir. Trans.*, 1823, vol. xii. p. 419); and Bouillars (*Arch. de Méd.*, January 1823, tom. ii. p. 192).

⁴ Robert Lee, *op. cit.* p. 116.

⁵ Lea, *Puerperal Infection*, p. 217.

names *phlegmasia alba dolens* and white leg, although they are hallowed by age.¹ Barnes² wrote of the former name, "an arbitrary compound of a pathological hypothesis and of a symptom would be inadequate even if it were not based on error."

Cellulitis seldom gives any difficulty in diagnosis on account of its well-marked physical signs. Very occasionally in long-standing cases of septic infection when pus is found pointing or discharging in unusual positions, *e.g.* the buttock, the bladder, vagina, or rectum, infiltration of neighbouring cellular tissues can be made out, and the question may arise as to whether cellulitis was the original condition or is only a secondary lesion from the tracking of a peri-phlebitic, adnexal, or even appendicular abscess. An examination of the pelvis together with a careful consideration of the history will usually lead to a solution of the problem.

Peritonitis.—Generally speaking, its signs and symptoms are like those arising from peritonitis due to perforation of the appendix, stomach, or duodenum, and are readily recognized. Like the surgical form the obstetric has many varieties, some most acute with severe symptoms, and rapidly fatal, some of insidious onset, long duration, and few signs and symptoms until just before the terminal signs of collapse appear. Other varieties are of intermediate severity. The obstetric form, however, is much more frequently of the chronic and less virulent type. On this account general peritonitis is sometimes overlooked until the time for successful treatment has passed. The writer would offer a warning note against this and the danger of being misled by the quiescent period so common in general peritonitis.

When the symptoms are severe but the pulse frequency is below 100 per minute, a gonorrhoeal peritonitis with tubo-ovarian infection may be suspected. A definite history of gonorrhoea, ophthalmia in the baby, an infection of the woman's urethra, of Skene's tubules or Bartholin's duct would, one or more of them, confirm the diagnosis. The importance of recognizing this form is considerable because it usually settles down, becomes limited in extent, and very rarely needs to be operated on during the acute attack.

Unfortunately general septic peritonitis in its early stages is frequently indistinguishable from gonorrhoeal peritonitis. The worse the general condition as indicated by the pulse and facial aspect of the patient, the greater the probability of septic peritonitis. Sudden onset in a patient not previously septic is in favour of gonorrhoeal peritonitis, and so are a history of gonorrhoea, signs of it at the vulva, and ophthalmia in the child. Women infected with gonorrhoea may, however, have

¹ First specially described by Mauriceau in 1721.

² Barnes, *System of Obst.* p. 433.

general peritonitis, resulting from septic infection of the uterus to which gonorrhoea appears to be a predisposing cause. When the nature and extent of the peritonitis are in doubt it is most unwise to wait for the progress of the disease to clear up the diagnosis, because, if the patient has general peritonitis, the opportunity for operating successfully will have gone by the time the diagnosis is no longer in doubt. In such cases it is much better to make a small exploratory incision above the pubes under local infiltration anaesthesia with 0.5 per cent novocain. If a limited gonorrhoeal peritonitis is found no harm will result unless the viscera are torn by deliberately breaking down adhesions, while in cases in which the peritonitis is unlimited and general, appropriate surgical treatment can be carried out with reasonable hopes of success.

It is desirable to consider the diagnosis of the *extent* of peritonitis in any given case. *Pelvic peritonitis*, as exemplified in the non-puerperal forms of pelvic inflammation which are usually of gonorrhoeal origin and associated with salpingitis, does not occur, except occasionally, and then late in the puerperium, in connection with abscesses of the uterine wall or tubo-ovarian infection. Peritonitis of a localized form, however, does not infrequently occur along with cellulitis, more especially when the ovary, or tube and ovary, are involved in this disease, and is diagnosed by the presence of the ordinary peritoneal signs and symptoms in a case of manifest cellulitis.

(3) *What is the offending organism or organisms?*—In order to obtain an answer to this question organisms must be sought for in: (a) fluid withdrawn from the uterine cavity; (b) blood taken from a vein at the bend of the elbow; (c) catheter specimens of urine.

Pus from cellulitis or peritoneal abscesses and fluid taken from the peritoneum when operating for general peritonitis may also be examined, but in these cases the bacteriological report is seldom or never useful in prognosis or treatment.

For withdrawing fluid from the uterine cavity the patient is placed in the left lateral position, a Sims's speculum passed, the cervix drawn to the outlet by a volsellum and cleansed with sodium bicarbonate solution. A glass catheter to which tubing is attached is now passed carefully into the uterine cavity, and by means of a glass syringe suction is applied and a sample of intra-uterine secretion withdrawn into the catheter. The openings in the catheter are closed by sealing-wax and the catheter sent to the bacteriologist. For these manipulations the surgeon wears sterilized gloves and uses sterilized apparatus.

The cavity of the puerperal uterus normally contains no organisms according to most authorities, but some investigators (*e.g.* Lea and Rowbotham) found organisms

in 80 per cent of puerperal uteri, although most of the cases were well and apparently perfectly normal. The different results are probably accounted for by the different methods of obtaining the samples from the uterus. Contamination by the secretions of the cervical canal is difficult to avoid by experienced investigators, and in ordinary clinical work a bacteriologically pure sample of uterine contents is probably not often obtained.

The best time to take blood from a vein is soon after a rigor. After rubbing the skin at the bend of the elbow with biniodide and spirit (1-500) a few drops of novocain (.5 per cent) are injected into the true skin over the selected vein. By applying a bandage firmly round the arm the vein becomes prominent and is exposed by incising the skin over it with a scalpel: 20 c.c. of blood should be withdrawn in a sterilized glass syringe, emptied into a sterilized test tube, and at once despatched to the bacteriologist.

With regard to reports on the blood examination positive evidence only is of value, for it is well known how difficult it is to find organisms in the blood stream.

The urine of puerperal women in perfect health is often found to contain organisms of the bacillus coli group. When organisms are in large quantity, and especially if pus cells are also found, the condition should be regarded as pathological, but it is often impossible to say whether the infection of the urinary passages is secondary to puerperal infection, or is a primary lesion which was present before labour. A history of urinary symptoms or recognized pyelitis existing previous to labour would be helpful in diagnosis, and if the organisms found in the urine and the uterus had the same characters the probabilities would be in favour of a secondary infection of the urinary organs from the uterus, more especially if the organisms found were not of the bacillus coli group. From these considerations it would appear advisable for the clinician to be careful not to place too high a value on the bacteriologist's reports, and it is better in the present state of knowledge to rely mainly on the clinical methods of diagnosis in cases of puerperal infection.

In investigating a case the greatest care must be taken not to do the patient harm by a long examination, by causing pain, or allowing her to exert herself in changing positions in bed, and especially by conveying infection from the vagina and the cervix into the uterus, or wounding the uterus and so implanting organisms into the venous sinuses.

Prognosis of Puerperal Infection

The estimated death-rate of septic infection arising after labour varies from 5 to 30 per cent, and it is probably much less when developing in connection with

abortion. The chief causes of death, judging from post-mortem findings, are septic foci in the lungs, malignant endocarditis, pulmonary embolism, and general peritonitis. Occasionally in cases of severe septicaemia no gross lesions can be found on post-mortem examination, and it must be assumed in these cases that toxæmia or bacteraemia is the immediate cause of death.

The prognosis depends upon a number of factors, the chief of which are : (1) the site and extent of the lesion ; (2) the form and virulence of the organisms ; (3) the resisting powers of the patient.

The site and extent of the lesions, and the morphology of the offending organism or organisms, can usually be determined, but knowledge is very incomplete in methods of estimating the virulence of the organism and the resistance of the individual.

1. Site and Extent of the Lesion.—The cases of most favourable prognosis are those of vulvo-vaginal infections, uncomplicated sapraemia, cellulitis, femoral thrombophlebitis, and pelvic peritonitis. Fatal results from any of these conditions are most unusual. On the other hand pyaemia and general peritonitis are very fatal forms of puerperal sepsis, while in cases of septicaemia it is advisable to give a guarded prognosis.

Vulvo-vaginal infections, although sometimes attended by high temperature and copious discharge, usually run a satisfactory course to complete recovery, and the scars remaining, even after extensive wounds, seldom cause trouble of any kind.

In *sapraemia* rapid recovery after evacuation of the uterus nearly always occurs, but in neglected cases, and when retained secundines are incompletely removed, pyaemia or septicaemia may develop. Occasionally, when every care has been taken during operation, one of these serious complications may arise. It is therefore desirable in cases of sapraemia to withhold the prognosis until two or three days have elapsed after emptying the uterus.

Cellulitis usually clears up with or without suppuration, and the patient gets quite well after a more or less prolonged illness. The possibility of future pregnancy is not in any degree impaired.

Pelvic peritonitis also runs a long course, and often ends in pelvic abscess, but is rarely fatal. Sterility and dysmenorrhoea are common sequelae.

In *femoral thrombo-phlebitis* a favourable prognosis may be given, but the risk of pulmonary embolism must be constantly borne in mind. Statistics show that embolism occurs in from 5 to 10 per cent of cases of thrombosis, and ends in death oftener than in recovery. It happens most frequently during the first ten days after the thrombosis appears, but the danger of embolism is not passed until the temperature has remained normal for at least three weeks. Femoral thrombo-phlebitis

sometimes terminates in the pyaemic and more fatal form of venous infection. Marked pyrexia, signs of suppuration, and accompanying thrombosis of the pelvic veins are unfavourable features, for pyaemia and pulmonary embolism are more likely to occur when one or more of these conditions exist. Subsequently varicose veins not infrequently develop, and troublesome oedema of the leg may persist for years.

Septicaemia.—In this common form of puerperal septic infection prognosis is much less determinate than in other forms of the disease. Early onset after labour, severe general symptoms, and a persistently rapid pulse, occurring apart from anaemia due to haemorrhage, indicate a severe type of the disease. The degree of pyrexia is not such a valuable index of the virulence of the infection as the features just mentioned, but, generally speaking, the higher the temperature the more serious is the disease, particularly if a high level of pyrexia is maintained. A large proportion, stated to be 60 to 70 per cent, of the severer types of septicaemia end fatally, usually from the toxæmia alone or from general peritonitis, but sometimes from pyaemia. The milder types, which are commoner, usually recover. It is estimated that about 10 per cent of them are fatal, but this is probably an excessive estimate. A guarded prognosis as to life should be given in cases of septicaemia because the mild types may develop into virulent types, may become complicated by peritonitis, or may end in pyaemia; on the other hand the severest types of the disease may recover, sometimes with remarkable rapidity. When recovery does result, it is usually complete and is not followed by any disabilities.

Pyaemia.—Cases of this affection have a high mortality. It would be useful in determining the line of treatment, operative or expectant, to be adopted in puerperal pyaemia if anything like an accurate estimate of its death-rate, when treated expectantly, could be formed. Bumm states that of 23 cases 19 died, *i.e.* a mortality of 83 per cent, but other authorities have collected large numbers of cases which show results somewhat more favourable. Statistics of the mortality in cases of puerperal sepsis are, however, not reliable because a considerable proportion of the cases occur outside hospitals and are not recorded, and of the fatal cases the primary cause of death is often omitted from the death certificates.

The writer has come to the conclusion from enquiries as to the experience of others, and from his own observations, that only a very small proportion of cases of puerperal pyaemia recover, and that the mortality rate in Bumm's personally observed series is probably not less than the average.

2. Form and Virulence of the Organism.—Prognosis depends to a variable and uncertain degree on the *morphology* of the organism or organisms found in the uterine cavity. Special significance must be attached to the presence of the

streptococcus pyogenes, as this is the organism most frequently found in cases of severe infection. Krönig and also Whitridge Williams, however, have recorded series of cases in which streptococci were found in the uterus with a mortality as low as 4 per cent. This is an exceptionally low death-rate for such an infection, and probably the results recorded by the members of the American Gynaecological Society of 30 per cent is nearer the average rate. *Staphylococci* are less commonly found, and are, as a rule, not so virulent as streptococci: occasionally the infection becomes generalized, and metastatic foci, such as pericarditis, may lead to a fatal issue. *Coliform bacilli* are found in cases with offensive discharge. The prognosis in such cases is usually very favourable. In mixed infections the prognosis appears to be unfavourable.

The *virulence* of organisms varies enormously, and it is apparently impossible by bacteriological reagents and modes of culture to distinguish varieties of any particular organism. Many authorities, however, claim that streptococci, which have haemolytic power, are more virulent than non-haemolytic streptococci. The source of the infection may now and again be helpful in estimating the virulence of an organism. If it is known that the infection was carried directly from a septic case of marked virulence, puerperal or otherwise, the probabilities are that the virulence of the organisms involved has not been diminished on re-infection.

The detection of organisms in the blood removed from a large vein is of great prognostic significance, and is generally unfavourable, more particularly when the streptococcus is found. Welch¹ reported a series of cases of streptococcal blood infections of which nearly 90 per cent were fatal.

When organisms are found in the urine it is difficult to judge as to their importance. They may be non-pathogenic and due to contamination from the urethra during the passage of the catheter, but if pus cells in abundance are also found in the urine the organisms are probably pathogenic. The lesion may, however, be a localized one, *i.e.* pyelitis, and more especially if the colon bacillus is the organism found. Should streptococci be found along with pus in the urine, in a case of puerperal infection in which streptococci are also found in the uterus, it is extremely probable that the organisms have passed through the kidney from the blood stream. *Post-mortem* experience shows that in such cases there are metastatic foci in the kidney, and therefore the prognosis is as bad as it can be.

3. The Resisting Powers of the Patient.—It is conceivable in view of the protective functions of leucocytes and the remarkable "righting forces" of the blood serum, *e.g.* opsonins, agglutinins, precipitins, etc., that prognosis in puerperal

¹ Welch, *Post-partum bacteriaemia*, Bulletin Lying-In Hosp., N.Y., March 1908.

infection depends to a very considerable extent on the natural resisting powers of the individual.

As in the case of the virulence of organisms, reliable methods for estimating these powers have not yet been devised. Nevertheless the virulence of an organism relative to a patient's power of resistance to infection can be roughly gauged by the effect of the infection, as manifested by the clinical features of the case. Generally speaking, it may be said that, in respect to corresponding anatomical lesions, the worse the general condition of the patient, of which acceleration of the pulse is the chief index, the greater is the relative virulence of the organism, and the less the resisting power of the patient to that organism.

Clinical experience teaches that patients exhausted by haemorrhage or by the shock of severe trauma, during or after labour, have a poor chance of resisting infection successfully, as have also alcoholics, ill-nourished patients, and those with renal affections.

Treatment of Puerperal Infection

Puerperal septic infection is preventable and its *prophylaxis* is described in books on Obstetrics.

The various forms of treatment that may be adopted for the cure of this disease will be considered under the following divisions: (1) general treatment; (2) specific treatment; (3) local treatment.

1. General Treatment.—Food should be given according to the patient's capacity for digestion. A diet limited to fluids usually ends in semi-starvation. It is most important to order liberal feeding and to encourage the patient to take solid food, due regard being given to the patient's desires and her appetite. Carbohydrate food is said to be especially valuable: honey on bread, and dissolved in water, are convenient ways of giving it. Abundant drinking water should be placed at the bedside so that the patient can help herself to it whenever she desires. Fowler's position is useful, for it facilitates peritoneal drainage and in cases of peritonitis the upper abdomen is less endangered. In all but mild cases lactation should be stopped, with a view to the conservation of the patient's natural resources.

Alcohol in any form is of doubtful value: in repeated large doses it may do much harm. Drugs may be given to relieve symptoms, such as pain, sleeplessness, constipation, or severe diarrhoea. It is customary to give ergot in full doses to promote uterine contractions with a view to the expulsion of septic material from the cavity of the uterus, thus checking the spread of infection through its muscular walls and the absorption of toxins. Gastro-intestinal disturbance is an indication for withholding or withdrawing ergot by the mouth and substituting intramuscular injections.

Injection of saline solution per rectum, subcutaneously or intravenously, relieves thirst, makes the patient feel more comfortable, and probably assists in the elimination of toxins. Glucose solution (5 per cent) given by continuous rectal infusion has the same effect; in addition it possesses a considerable nutritive value, and is of great value in the treatment of most forms of puerperal infection.

Infusion of Blood.—Encouraged by Crile's results from the direct infusion of blood some American and Continental (Tuffier)¹ gynaecologists have adopted this method for the treatment of puerperal infection, and have met with some success. If it were only for the treatment of the profound anaemia which is present in many cases of puerperal infection, infusion of blood would not be unreasonable, and the infusion of healthy blood serum in large quantity can hardly fail to have some bactericidal value. There are two methods in use for the transference of blood from the vessels of one individual to those of another, *direct* and *indirect* infusion. The technique of both methods, especially the direct, offers many difficulties, but with care and a little experience it can be carried out safely and quickly. The indirect method is the one mainly used in this country.

(i.) *Direct Method.*—The radial artery of the donor is connected by means of a cannula with a superficial vein of the receiver. This may be done in one of three ways: (a) making a cuff of the *vein* of the *receiver* over the cannula and drawing the artery of the donor over the cuff (Crile²); (b) cuffing the *artery* of the *donor* over a special cannula (Elsberg³) and inserting it into the vein of the receiver; (c) connecting the artery and vein by means of an ordinary glass or metal cannula which has been sterilized in and kept in paraffin (Tuffier⁴). Similarly transfusion may be done from a vein of the donor to a vein of the receiver.

By the first two methods the undamaged intima of the blood-vessels alone comes in contact with the blood stream. For an account of the technique, necessarily elaborate, of the procedure, the reader is referred to the writings quoted.⁵

(ii.) *Indirect Method.*—The technique of this is simpler and the method has the additional advantage that the amount of blood given can be measured. Two operators are advisable, one to take the blood from the donor, and the other to inject it into the receiver. Four or five syringes are required in order to avoid delay from washing and preparing syringes which have been used. The syringes should be of about 30 c.c. capacity, made of glass, with glass pistons and long tapering nozzles (Fig. 245). They are sterilized and kept in hot saline solution. The median basilic vein of the donor is dissected out under local anaesthesia, tied at the *upper* end of

¹ *Brit. Journ. of Surgery*, vol. ii. No. 5, p. 158.

² *Annals of Surgery*, September 1907.

³ *Journ. of Amer. Med. Assoc.*, March 15, 1909.

⁴ *Brit. Journ. of Surgery*, vol. ii. No. 5, p. 158.

⁵ *General Surgery* (Texer-Bevan), p. 1008.

the wound and clamped at the lower. It is divided near the ligature and the lumen of the distal portion is held open by mosquito forceps. In the case of the receiver, after dissecting out the corresponding vein it is tied and divided at

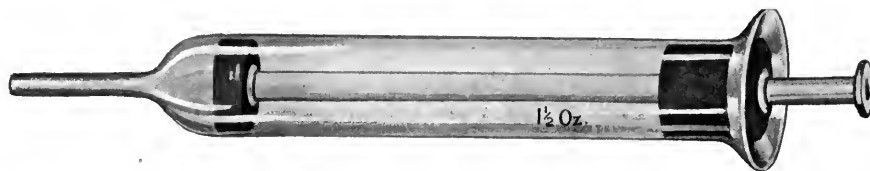


FIG. 245.—Glass syringe, $1\frac{1}{2}$ oz. capacity, used by the writer for indirect transfusion of blood ; the piston is fitted with a rubber ring.

the *lower* end of the wound and clamped at the upper, the proximal end being held open by mosquito forceps. After testing the syringe with saline solution, about 5 c.c. of a 1.5 per cent solution of sodium citrate in 0.85 per cent NaCl is drawn into syringe in order to delay clotting. The nozzle of the syringe is inserted into the open end of the donor's vein which is then drawn over the nozzle with the mosquito forceps. The clamp on the vein is loosened, a syringeful of blood withdrawn, and the syringe passed on for injection into the receiver. The nozzle is inserted, the clamp relaxed, and the blood injected. This process is repeated until it is considered that enough blood has been given. As a rule 200 c.c. to 250 c.c. are sufficient.

Recently Moynihan has devised a simpler method which is satisfactory in practice. He uses glass or metal cannulae such as are used for saline infusion and made to fit glass syringes. A cannula is passed into receiver's vein in the direction of the blood current and tied in position and another cannula passed into the donor's vein in the opposite direction. Blood is withdrawn out of the donor's cannula and injected by an assistant into the receiver's, a finger being applied to each cannula to stop the escape of blood when the syringe is removed. Several syringes are used, each being washed in sterilized saline after every injection so that no blood remains in the barrel. There is a small risk of haemolysis occurring, but it can be guarded against by having a laboratory test made before transfusing. Positive results in the test-tube, however, are not always followed by haemolysis in the individual. Crile says that the normal blood of one individual does quite as well as that of another. Kinship apparently is of no special advantage.

In a recent case under the writer's care jaundice and haemoglobinuria followed indirect infusion for puerperal infection following puerperal haemorrhage, but the patient suffered no untoward symptoms. The temperature promptly came down to normal, and the general condition was strikingly improved.

2. Specific Treatment.—A few years ago clinicians were led to expect great assistance from this form of treatment. Up to the present, however, it must be admitted that it is of uncertain value. There are two varieties : (a) serum therapy ; (b) injection of chemicals.

(a) *Serum Therapy.*—The subcutaneous or intravenous injection of *antitoxic sera* has been extensively used during recent years, and many favourable reports have been published. The general opinion of those who see many cases of puerperal infection is that sera are of doubtful value. Antistreptococcal serum does occasionally appear to be helpful, more particularly in the early stages of a severe streptococcal infection of the uterus. The writer usually gives large doses, 40 c.c. or more, repeated two or three times only. It must be fresh and polyvalent. It is said to be dangerous when there are undrained foci of suppuration, so that in the later stages and when gross lesions are found it is more prudent not to give it.

Vaccines.—Vaccines prepared from organisms found in the patient's uterus or blood stream may be tried after serum has failed. Stock vaccines are not advised by bacteriologists, although a recent form, "activated vaccines," may prove as valuable in puerperal sepsis as it appears to be in some medical and surgical infections.

(b) *Injection of Chemicals.*—This method of treatment, though extensively tried on the Continent, has not been adopted in this country. It is said to produce a leucocytosis and thus to be useful in septic infections. The chief preparations are collargol, nucleinic acid, and turpentine.

Collargol is given intravenously with a Luer's syringe, 10 c.c. of a 1 per cent solution being used once a day. *Nucleinic acid* is given hypodermically twice daily in doses of 1 or 2 drachms of a 2 per cent solution.

Turpentine : 1 drachm is injected into the subcutaneous tissues of the anterior abdominal wall with the object of forming an *abcès de fixation*. Foci of suppuration are commonly observed coincidently with improvement in a patient's general condition in cases of puerperal infection, and it has been inferred that the pus formation is the cause of the improvement in such cases. Accordingly foci of suppuration have been produced artificially in the treatment of puerperal sepsis. The formation of pus, however, is probably only a local result of the conflict between the offending organisms and the defensive forces of the patient, and not a natural therapeutic process to assist in the defence against the organisms. Many good results have been reported to follow this form of treatment, but it is of doubtful value, and though harmless, its adoption cannot be recommended.

3. Local Treatment of Puerperal Septic Infection.—For the most part the

general and *specific* treatment just described refer to all the clinical forms of infection. The *local* treatment depends upon the structures involved, and we must therefore consider this treatment as it is applied to each of the clinical forms of the disease separately. It may be said at once that although during the last twenty years much discussion has centred round the many kinds of local treatment, it is now generally agreed by experienced clinicians that expectant treatment yields better results than operative treatment, in most cases of septic infection. This refers more particularly to the common form of the disease, viz. uncomplicated uterine infection. On the other hand the value of incision and drainage of suppurating foci in the cellular tissues and the peritoneum is no longer questioned.

(1) *Uterine Infection*.—The variety of uterine infection called “putrid endometritis” referred to on p. 529 is clearly suitable for local treatment, and evacuation of the decomposing masses from the cavity of the uterus is indicated. As previously stated, this condition of the uterus is rare after labour, and uncommon after abortion, so that while this form of treatment is valuable when definite evidence exists of the retention of decomposing masses, the occasion for its adoption seldom arises. The simple procedure need not be detailed, but the danger of infecting the uterine wall, and particularly the venous sinuses, must be pointed out. If sterilized gloves are worn and only the fingers used for separating the masses from the uterine wall, little danger is incurred. Curettage by the practitioner is to be strongly deprecated, for puerperal pyaemia and infective endometritis not infrequently follow curettage for putrid endometritis, and, moreover, perforation of the uterine wall may occasionally occur.

The local treatment of “infective endometritis,” in the opinion of the writer, is, on the whole, best avoided. An intra-uterine douche of normal saline solution may be tried without incurring much risk if scrupulous care be taken not to damage the uterine wall with the cannula, and not to carry infection from the vagina or cervix into the uterine cavity.¹ It will be found that a very convenient occasion for irrigating the uterus is immediately after taking a sample of uterine contents for bacteriological examination. The cervix is then exposed, drawn down, and cleansed, so that a cannula can be readily and safely passed through it. Experience teaches, however, that this procedure seldom does good. On the contrary, it often does harm, as also do most forms of intra-uterine treatment for this condition. The

¹ Antiseptic solutions are not necessary and may be harmful. Wright has shown and military surgeons have confirmed his opinion that when infection is established antiseptics are of little or no use. Lord Lister himself clearly distinguished the difference between the prophylactic and the therapeutic value of antiseptics; he emphasized the all-importance of the former, and pointed out the inadequacy of the latter.

pathological fact of the penetration of organisms beyond the surface of the endometrium in this lesion, adequately explains the futility and also, to some extent, the danger of these procedures.

It occasionally happens that although the nurse reports that a patient has little or no lochial discharge a copious flow will escape from the cervix during the process of investigating a case of pyrexia after labour. This condition, *lochiometra*, is best treated by a free irrigation of the uterine cavity.

Vaginal douching, so commonly adopted in uterine infection, is probably harmless if given at low pressure, and may be useful in washing away discharges and stimulating uterine contractions. It must, however, be borne in mind that these cases tolerate any interference badly, and anything which unduly disturbs the patient's comfort is to be avoided.

Curettage as a routine measure in all cases of puerperal endometritis can be unequivocally condemned, for the reason that in the most severe cases there usually is absolutely nothing in the uterine cavity which can be removed, and its employment can only do harm by breaking down the leucocytic wall which serves to prevent the invasion of the deeper layers of the uterus by the offending bacteria. On the other hand, when the uterus contains much *débris*, its removal is more readily effected by means of the finger than by the curette. Most authorities direct that in the early stages of all puerperal uterine infections a careful digital exploration of the uterine cavity should be made under anaesthesia, and if its interior is rough and jagged and contains more or less *débris*, it should be thoroughly cleaned out with the finger, after which an abundant sterile saline douche should be given.

Hysterectomy would appear to be at first sight a rational if bold attempt to free the patient from her disease. Experience most conclusively shows that it should not be thought of. This operation is, however, eminently useful in cases of infection of uterine fibroids occurring after labour or abortion.

(2) *Pelvic Peritonitis*.—The local treatment of this condition by posterior colpotomy is highly successful. Evidence of effusion in Douglas' pouch, *i.e.* fulness, rigidity, and tenderness in the posterior fornix, is the indication for the operation. A rubber drainage tube should be inserted and stitched into position. General anaesthesia is not usually necessary.

(3) *Infection of the Appendages*.—This rarely requires local treatment other than hot applications for the relief of pain. Should definite evidence of a collection of pus become manifest then drainage, preferably by the vagina, should be adopted.

(4) *Pelvic Cellulitis*.¹—In the early stages of this condition rest and symptomatic

¹ See also Article on Pelvic Cellulitis (p. 649).—EDITORS.

treatment alone are required. In most cases the inflammatory swelling will subside without suppuration, but in others it does not do so. Recrudescence of pyrexia with persistence or enlargement of the inflammatory tumour are evidence of pus formation. Incision and drainage of the abscess cavity should be carried out as soon as possible in the most favourable position. This is usually above and parallel to the outer part of Poupart's ligament. When pus points in the roof of the vagina it should be evacuated per vaginam and drained.

(5) *General Peritonitis*.—Cases of general peritonitis arising during the puerperium, like the ordinary surgical cases due to perforative lesions of the gastro-intestinal tract, probably never recover unless they are treated by operative measures. Surgeons have conclusively proved that the time factor more than any other consideration influences a patient's chance of recovery from the surgical forms of the disease, and if favourable results are to be obtained in cases of puerperal general peritonitis they will have to be attacked by operation in their early stages. Unfortunately there is often considerable difficulty in making an early diagnosis in general peritonitis arising after labour or abortion, and the patient is usually not operated upon until nearly past hope of recovery.

The chief cause of the delay in making a diagnosis arises from the fact that gonorrhæal peritonitis, which is usually limited in extent and does not require urgent operative interference, often resembles in its clinical features the early stages of general peritonitis due to septic infection. Instead of waiting for the diagnosis to be cleared up by the course of the peritonitis, as is so frequently the case, it is better to make an exploratory incision under local anaesthesia to settle the question at once. Difficulty in detecting general peritonitis in its early stages occurs also in cases of insidious onset, and especially when the patient is seriously ill from septic uterine infection, and the symptoms due to the onset of peritonitis are obscured by those of the primary lesion. In such cases acceleration of pulse-rate, as has been observed in peritonitis due to perforation of typhoid ulcer, is a most valuable early sign, especially when found in association with abdominal pain, tenderness, and rigidity, although these abdominal features may not be marked. During the necessary interval between the diagnosis being made and the performance of the operation, the patient should be propped up in bed and receive a subcutaneous or intravenous infusion of saline solution and $\frac{1}{6}$ gr. of morphia hypodermically. A local anaesthetic (0·5 per cent novocain) combined with open ether anaesthesia should be used, the abdomen opened suprapubically, and as much of the intraperitoneal effusion removed as possible. If a local focus of suppuration, *e.g.* pyosalpinx, should be detected, it must be dealt with *secundum artem*. A long piece of wide rubber drainage tube

should be passed to the bottom of the pelvis, and other tubes into the renal pouches. If the patient's general condition permits, the renal pouches should be separately drained in the lumbar regions. Douglas' pouch should always be drained through the posterior vaginal fornix as well as suprapubically. When the patient appears to be too ill to stand these procedures, a posterior colpotomy under local anaesthesia may be done. For this it is not necessary to remove the patient from her bed.

The *after-treatment* is important. The patient should be propped up in bed so as to be sitting as nearly upright as possible and a continuous rectal infusion of glucose solution (5j to Oj) administered. Water may be given freely by the mouth, and also sodium bicarbonate solution (3j to Oj) in cases where vomiting persists. Intestinal distension may often be relieved by hypodermic injections of pituitary extract.

(6) *Venous Infection*.—(a) The *white leg* variety of infection of the large veins should be treated by immobilization and elevation of the limb or limbs affected. Hot fomentations may be applied over painful areas. Voluntary movement should not be allowed until the temperature has remained normal for three weeks. Palpation and rubbing of the regions of the main veins of the limb increase the danger of pulmonary embolism, and both nurse and patient should be instructed not to handle or wash the limb. When embolism occurs the patient's fears should be calmed, half a grain of morphia injected, and oxygen administered.

(7) *Puerperal Pyaemia*.—This common and grave condition may be treated expectantly or by operation. Although the statistics of some operators¹ show remarkably good results and much better than could be expected from any other treatment, it is doubtful whether operative treatment as a rule gives a greater percentage of recoveries than the expectant method. It must be admitted that the comparison of the results of the two forms of treatment is somewhat misleading on account of the relatively few cases operated upon, and because probably most of them are of the severest type of the disease. If the expectant line is followed, foci of suppuration must be searched for every two or three days, more particularly in the buttock and the back, and the chest carefully examined for pleural effusion. No time should be lost in dealing with such lesions on ordinary surgical principles. It is remarkable that few or no local symptoms may accompany such complications. Septic broncho-pneumonia and abscess in the lung, which are common complications, do not yield as a rule to surgical treatment.

The *operative treatment* of puerperal pyaemia, though probably sound in theory, has been hitherto not very successful in practice. The object of the operation is to cut off the infected area from the circulation by ligaturing the vein on the cardiac

¹ Whitridge Williams, *Am. Journ. Obs.*, May 1909.

side of the lesion. There are technical difficulties in carrying out the operation, and the patient is often too ill to withstand any severe measures. The procedure is described in the Article on Ovariectomy (Vol. III. p. 437).

After this operation the rigors cease, although pyrexia may persist for a while in consequence of some other focus of infection. Unfortunately recurrence of the rigors is only too frequent, and a fatal issue is quite common; septic bronchopneumonia, malignant endocarditis, and infective thrombosis in the vena cava being the commonest *post-mortem* findings.

The most favourable cases for operation and also for expectant treatment are the chronic forms of the disease, and the least favourable the acute cases with frequent rigors and severe toxæmia. Heart and chest lesions are absolute contraindications to the operation. Careful nursing and gentle handling of the patient are very desirable in the after treatment.

NON-PUERPERAL SEPTIC INFECTIONS

This common class of septic infections differs in an important respect from the puerperal class, for it occurs, with few exceptions, only as a *complication of other lesions*. This is somewhat remarkable in consideration of the fact that septic organisms can usually be found in the vagina of a parous woman at any time apart from pregnancy. An explanation of this relative immunity of the non-puerperal organs from uncomplicated septic disease, is the presence of natural protective barriers, of which the chief appear to be, the epithelium-covered surface, the vaginal secretion,¹ and the closed internal os. When these defences, one or more of them, are broken down, by wounds, specific infection, or ulcerating new growths, septic infection readily takes place. Other outstanding features of the non-puerperal septic infections are the tendency to *localization* of the disease, and the relative infrequency of severe toxæmia and of involvement of the uterine wall and the appendages.

Non-puerperal septic infections may be conveniently classified into :

(a) Primary Septic Infections.

- (1) Traumatic, *e.g.* operation wound.
- (2) Non-traumatic, *e.g.* senile vaginitis.

(b) Secondary Septic Infections.

- (1) Of new growth, *e.g.* cancer of cervix.
- (2) Following specific infections, *e.g.* gonorrhoea.
- (3) Extensions from septic infection of neighbouring structures, *e.g.* appendicitis.

¹ T. Harada, *Amer. Journ. of Med. Sciences*, August 1916.

Most of the above varieties of the disease are described in other parts of this work, and need only be shortly referred to here. *Pyometra*, an interesting clinical form of septic uterine infection, will, however, be described in this article.

(a) **Primary Septic Infections.**—(1) *Traumatic Septic Infection.*—Septic operation wounds are the commonest variety of this form of the disease, but ulceration of the vagina due to the pressure of a pessary, and septic vulvitis from scratching, frequently occur. While, generally speaking, operations on the pelvic organs yield results probably as successful as those of any other region, sepsis is apt to develop after operations for genital prolapse, cancer of the cervix, and infected fibroids.

Plastic operations for prolapse do not, as a rule, heal aseptically, but they seldom suppurate deeply or extensively. The danger to life from deep infection is slight, but pulmonary embolism occasionally causes sudden death, even in cases of apparently mild infection. Suppuration of the wound increases the risk of recurrence, and is probably the most important factor contributing to the non-success of any type of operation for prolapse. The commonest causes of infection are ulceration of the cervix or vagina, and a copious purulent discharge; it is therefore desirable to postpone the operation for prolapse when either of these conditions is present.

With respect to the radical operation for cancer of the cervix instanced above as a proceeding liable to be followed by septic infection, Bland-Sutton has recently drawn attention to the magnitude of this danger, and pointed out that colonization of the growth by streptococci is the explanation of it. Nevertheless infection of the raw surfaces made during this operation can be prevented by taking the minute precautions described in Vol. III. p. 490 in the account of Wertheim's operation for cancer of the cervix. Extirpation of the growth by the vaginal route usually results in a septic wound, though not of a serious kind, on account of the small extent of the raw surface and the efficient drainage which can be maintained.

Fibroid tumours of the uterus are as a rule removed with a high degree of safety, but sepsis occurs sometimes, more particularly when the tumour is already infected. The precautions to be taken against infection are dealt with elsewhere, but it is desirable to mention here the danger of perforating a septic focus when a corkscrew or volsellum is used for the purpose of dragging these growths through the abdominal incision. Curettage for the relief of menorrhagia due to a fibroid, may result in infection of the tumour through the endometrium, or infection of the uterine cavity which may extend to the peritoneum. Vaginal myomectomy may result in serious infection of the uterine wall especially in the case of infected tumours.

Pulmonary embolism occurs in about 1 per cent of all cases of hysteromyomectomy, according to Bland-Sutton. This serious consequence of infection

need not be so frequent, and can be lessened by punctilious care in technique, and the use of sterilized catgut instead of unabsorbable ligatures.

Two other common examples of traumatic septic infection are ulceration of the vagina from the pressure of a pessary, and infected scratches on the vulva. Pessary wounds are usually superficial and seldom cause serious trouble, but occasionally a rigid instrument may be left in the vagina so long that it ulcerates through the vagina and into the bladder or rectum, or even into both bladder and rectum. The rubber ring when retained for months may cause a superficial ulceration, or a septic vaginitis, from which occasionally an ascending infection of the uterus may result.

Scratch wounds of the vulva do not differ materially from similar septic wounds in other parts of the body. It is important, however, to remember that vulval disease associated with pruritus may become inveterate on account of this complication.

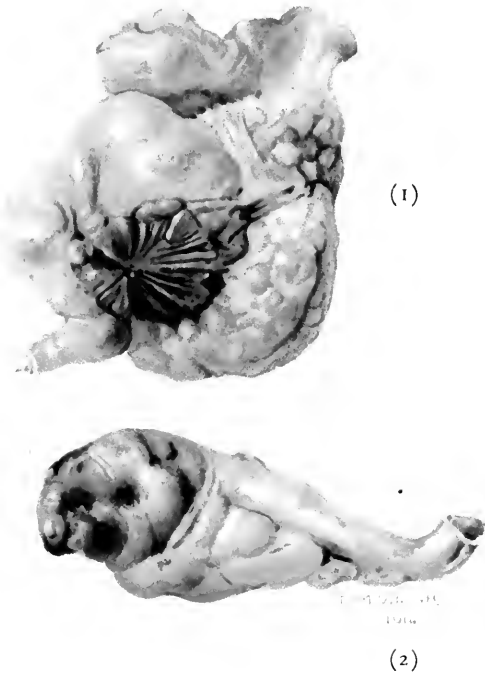
The *uterine sound* was formerly much used in the diagnosis and treatment of pelvic conditions; probably it often introduced infection into the uterus, and sometimes produced septic perforative lesions which led to peritonitis or cellulitis.

(2) *Non-traumatic Septic Infection.—Vaginitis.*—Although septic infections of a serious nature are rare apart from wound infections and secondary infections of other diseases, *superficial* infections of the vagina, and the vaginal portion of the cervix, are probably common. Leucorrhoea, for instance, is often of this nature, and as a rule nothing worse results from it than a disagreeable discharge. In some cases a definite vaginitis is observed. A gaping introitus, a vaginal pessary, frequent douching, and residence in hot climates, appear to be common predisposing causes of vaginitis. The vagina has a catarrhal appearance, the surface epithelium readily comes away, and bleeding may result when the surface is rubbed with a swab. Deep red spots like superficial ecchymoses may be seen here and there, particularly in the fornices.

A common clinical form of vaginitis occurs in women who have passed the menopause, viz. *senile vaginitis*. The discharge is thin, usually profuse, and may at times be blood-stained. The red spots are usually numerous, and may be seen at the introitus as well as in the vagina. Pruritus vulvae or even chronic vulvitis may be associated with it, and adhesions of the vaginal wall occasionally result from it. Septic vaginitis can also occur, although it may be unattended by symptoms, when septic discharge from the uterus or a pelvic abscess drains into the vagina, and also when urine or faeces escape into it.

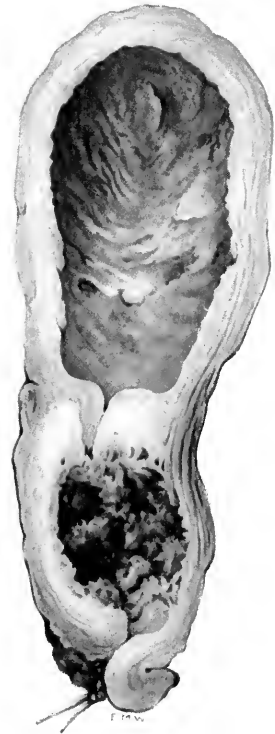
Septic Endometritis.—Uncomplicated septic infection of the cavity of the uterus is probably very rare. It occasionally occurs in elderly women, when it is known as

A



- A. (1.) Acutely inflamed tube and ovary. The distal end of the appendix (2) was firmly adherent to the fimbriated end of the tube. There was a small abscess in the meso-appendix.

B



- B. Pyometra due to cancer of cervix.

senile endometritis. This form is usually associated with senile vaginitis, and is probably due to infection ascending from the septic vagina. The symptoms resemble those of senile vaginitis, viz. purulent discharge which is occasionally blood-stained. Sometimes haemorrhage, which is never severe, may occur, and it is often this symptom which leads the patient to seek advice from the fear of malignant disease. If a vaginal speculum is passed and the surface exposed pus may be seen oozing from the external os. Pyometra, which will be described later on, occasionally ensues from senile endometritis.

The part which septic infections play in the various forms of chronic endocervicitis and of chronic endometritis, and in fibrosis uteri will be discussed elsewhere.

Furunculosis, acne, and other septic infections of the vulva need only be mentioned since they resemble in most respects the same diseases in other parts of the body.

Many physicians, and especially those who practise at the Spas, appear to believe that septic infections of the vagina and cervix are frequent causes of chronic articular rheumatism.

(b) **Secondary Septic Infections.**—This is by far the most important class of septic infections of the non-puerperal pelvic organs, for it includes the commonest and most serious forms of the disease.

The modes of infection, consequences, and dangers of the secondary infections of new growths are described in the articles on the various forms of new growth of the pelvic organs, and the bearing of secondary infection on the specific infections—gonorrhoeal, tubercular, and syphilitic, will be discussed in the chapters devoted to these subjects.

Appendicitis.—As regards infections of the pelvic organs from the extension of septic infection from neighbouring structures, by far the commonest example of these lesions results from appendicitis, the usual sites of the infection being the right appendages, the pelvic peritoneum, and occasionally the pelvic cellular tissue. The danger to life from acute appendicitis is not usually increased by this complication, except when a pelvic abscess is overlooked at the operation for acute appendicitis or subsequently.

The involvement of the *appendages*, especially on the right side, rarely calls for treatment directed to them during the acute stage of the disease. Occasionally an ovarian abscess or acute salpingitis (see Plate XIII. A) may be found in an inflammatory mass about the diseased appendix, necessitating the removal of the affected

appendages, or they may be found subsequent to a patient's recovery from operation for an appendix abscess.

Pelvic abscess due to appendicitis may be serious when it occurs during pregnancy on account of the risk of abortion resulting, the difficulty of obtaining good drainage of the abscess, and the danger of infection of the uterus after abortion especially when the pelvic abscess drains vaginally. Pelvic cellulitis results from retroperitoneal infection spreading usually from a retrocaecal or pelvic appendix. The cellular tissues about the rectum are most frequently involved, and occasionally the rectum may be completely surrounded by an inflammatory mass. Pus may point into the rectum or vagina, and after its escape, spontaneously or by incision, the symptoms and the swelling disappear.

The *after-effects* of pelvic inflammation spreading from appendicitis are of clinical importance, and probably more so than they are generally supposed to be. They result chiefly from adhesions. It is well known that after peritonitis adhesions may disappear, but sometimes they remain anchoring the uterus in the retroflexed position, fixing the ovary in its fossa on the lateral pelvic wall, and constricting even to closure, the abdominal ostia of one or both Fallopian tubes. They resemble closely the results of gonorrhoeal infection, but as a rule the abdominal ostia of the tubes are not completely closed, and hydrosalpinx and pyosalpinx do not occur as in gonorrhoeal infection. These adhesions as a rule cannot be detected by ordinary clinical examination, but only after opening the abdominal cavity. The chief symptoms which may result from them are pains during menstruation, which is usually worse on the right side, and sterility. Adhesion of the uterus to the rectum draws it backwards and lessens its mobility (Fig. 246). This condition may not often produce symptoms, but should pregnancy occur various complications may arise, such as abortion, which may be repeated, and incarceration of the gravid uterus. Torsion of the Fallopian tube, producing acute haematosalpinx with acute abdominal symptoms, may occasionally follow adhesion of some of its fimbriae to neighbouring parts. Again it is possible that infection may travel through old adhesions¹ from the intestines to the pelvic organs, and so be a cause of such lesions as ovarian abscess, infection of ovarian or uterine tumour, or haematoma of the ovary.

Other Causes.—Adhesions following appendicitis have alone been mentioned, but similar results may follow peritonitis after perforated gastric, or duodenal ulcer, diverticulitis,² and probably also pelvic haematocele. In addition to the uterus and

¹ Fothergill, *Med. Magaz.*, October 1910.

² Oldfield, *Journ. Gyn. and Obst. Brit. Emp.*

its appendages, the *vagina and vulva* may be implicated in the septic infection of neighbouring organs usually in the form of paravaginitis. Abscess of the posterior vaginal wall can be usually traced to an anal or rectal fistula.*

Tertiary syphilitic disease of the rectum is often accompanied by septic sinuses discharging into the vagina and on the perineum.

Abscess in the anterior vaginal wall may result from infection of the urethra and from appendix abscess. Other but rarer examples of septic paravaginal lesions

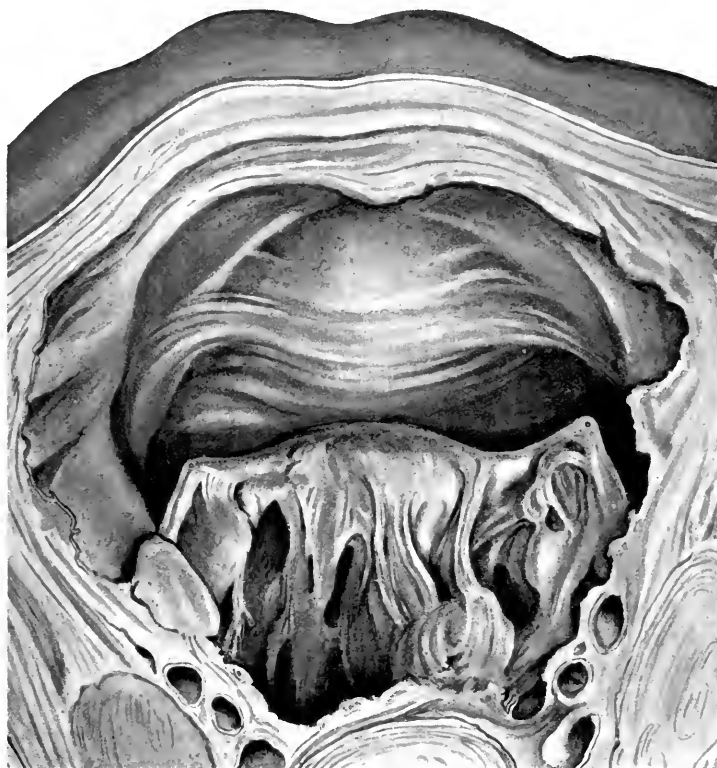


FIG. 246.—Adhesions left after pelvic peritonitis. (Dissecting-room specimen.)

are congenital cyst of the vagina and haematocolpos associated with double uterus and double vagina, which have become infected, directly from the rectum or indirectly through the blood stream.

Pyometra

In this septic condition the uterus is distended with purulent fluid. It occurs usually as a complication of some other disease, and is most frequently associated with cancer of the cervix uteri (Plate XIII. B). The septic new growth in this instance readily leads to both obstruction and infection. Another common form of pyometra, unconnected with new growth or other gross lesion, is met with in women

who have passed the menopause. In these cases the cervix is often stenosed by cicatricial contraction, but occasionally uterine dilators can be passed without meeting abnormal resistance. When no organic obstruction is present retention of fluid may be accounted for by loss of contractile power in the uterine wall (Fig. 247). It is



FIG. 247.—Small senile pyometra removed *post mortem*; note the long cervix and the small uterine cavity. (Leeds Museum.)

said that retroflexion, in which position the uterus is sometimes found in such cases of pyometra, may also hinder the outflow of fluid through the internal os. These senile forms are often associated with vaginitis, and probably ensue from senile endometritis.

Other types of this condition are encountered on rare occasions (*a*) in connection with gonorrhoeal infection of the uterus (Fig. 248), (*b*) in tuberculous disease (Fig. 260, p. 607), (*c*) subsequent to the removal of a sloughing tumour from the cavity of the uterus, and (*d*) from ascending infection after opening a haematocolpos combined with haematometra (Fig. 249). When it arises as a complication of gonorrhoeal endometritis, excessive local treatment by caustics or the cautery has usually been applied to the cervix, resulting in cervical stenosis and septic infection of the uterine cavity. After cutting away a septic fibroid, and after opening a haematocolpos, retention of purulent fluid in the cavity of the uterus is probably due to inefficient contractile power of the uterine muscle, as in the case of *lochiometra*

which sometimes occurs after labour. The infection, more particularly in acute forms of the disease, may extend to the tubes and even to the peritoneum, producing acute pyosalpinx and pelvic peritonitis.

Pathology.—The retained fluid is usually a thin offensive pus, from which the bacillus coli has frequently been cultivated, but which in some instances has proved sterile. The uterine wall is usually thin, soft, and easily lacerated, but when the condition occurs as a complication of fibroid tumour or haematocolpos it is thickened and firm. The cavity of the uterus usually has a smooth surface to which pus

adheres. When associated with new growth in the corpus uteri or the cervix, sloughing areas may be seen. When pyometra is secondary to a gonorrhoeal infection, chronic salpingo-oöphoritis may be present.

On microscopic examination the endometrium is usually very thin, and may be absent in places. The surface epithelium, usually staining badly on account of degeneration, may be found here and there, and as a rule but few glands are observed (Fig. 250). The endometrium shows small-celled infiltration, but the muscular

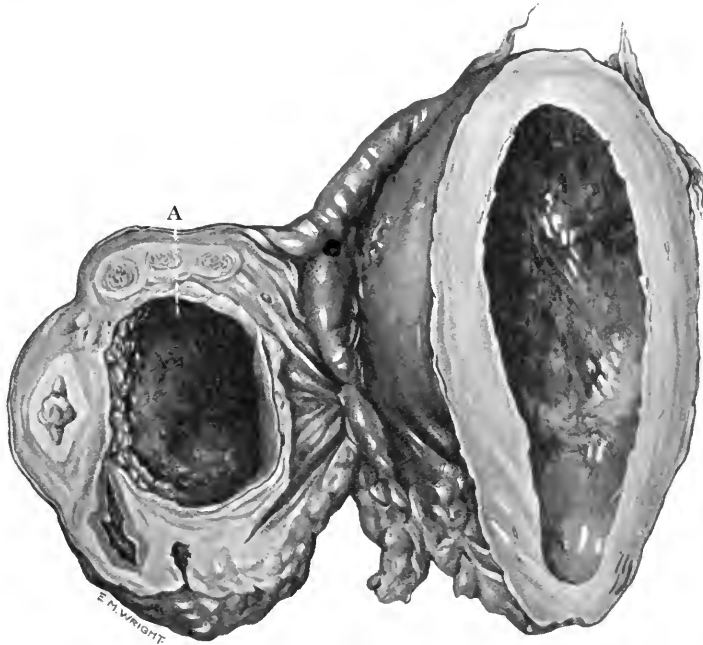


FIG. 248.—Pyometra with stenosis of the cervix secondary to chronic gonorrhoeal infection. There is associated chronic salpingo-oöphoritis with abscess of the corpus luteum (A).

wall is usually free from inflammatory exudation, except in cases when a septic new growth involves the muscle.¹

Symptoms.—The symptoms vary considerably, in some cases being most severe and in other cases hardly noticeable. The difference depends largely on the primary lesion. When arising from cancer of the cervix, pyometra as a rule produces few or no additional symptoms, but occasionally acute hypogastric pain, pyrexia, and a general aspect of septic infection develop. The body of the uterus is enlarged, cystic, and tender, and a stream of offensive pus may run away while vaginal examination is being made. In the senile forms of pyometra the leading and often the only symptom is a foul vaginal discharge which at intervals becomes profuse. Pain and

¹ The changes found in pyometra from cancer are fully described in the Article on Cancer of the Uterus (Vol. II. p. 478).—EDITORS.

pyrexia may occur, but they are not common symptoms. The enlarged, cystic, and tender uterus is readily recognized on physical examination, and senile vaginitis is often present.

In contrast with the symptoms in the above common varieties of the disease, pyometra, occasionally found after the operation for septic fibroid tumour, and for haematocolpos, usually produces acute symptoms resembling those of acute puerperal infection, viz. high temperature with rapid pulse, abdominal pain, and offensive vaginal discharge.

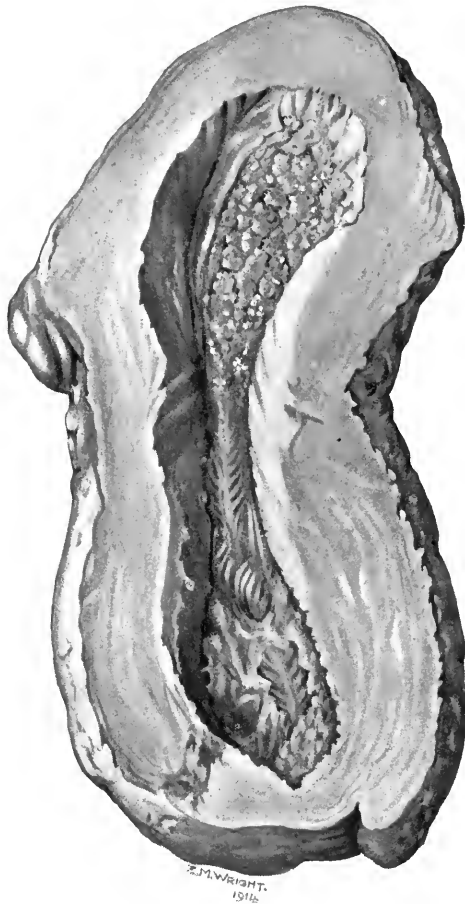


FIG. 249.—Pyometra which developed after drainage of the vagina for retained menses. Removed by operation. (Leeds Museum.)

In connection with all the varieties of pyometra acute salpingo-oöphoritis and pelvic peritonitis may ensue, in which event the symptoms of acute pelvic inflammation mask those due to the pyometra.

Diagnosis.—When secondary to cancer of the cervix, pyometra often escapes recognition, especially when it arises in the late stages of the growth. It may be discovered during an operation for the treatment of the cancer, *i.e.* when curetting away the necrosed tissues or performing hysterectomy. If, however, a systematic examination of the corpus uteri were made during the ordinary physical examination of cases of cancer of the cervix, pyometra would be more frequently diagnosed before operation and many an unpleasant surprise thus avoided.

In the absence of palpable growth of the cervix a complete diagnosis can seldom be made until the uterus is explored under anaesthesia. Endocervical cancer can then be readily recognized by the curette if not by the finger, and cicatricial stenosis of the cervix is easily detected by the use of uterine dilators.

Since vaginitis frequently accompanies pyometra an examination under an anaesthetic is often desirable in cases of profuse vaginal discharge, occurring in women past the menopause, in order to determine whether the lesion is limited to the

vagina or is chiefly uterine. The presence or absence of a cystic uterine enlargement, and of a copious offensive discharge from the cervix usually leads to a prompt diagnosis. In doubtful cases intra-uterine exploration, after dilating the cervix, is required.

With respect to the rarer forms of pyometra coming on after the removal of uterine tumours, and after opening haematocolpos the acute symptoms and profuse offensive discharge unmistakably point to the nature of the complication.

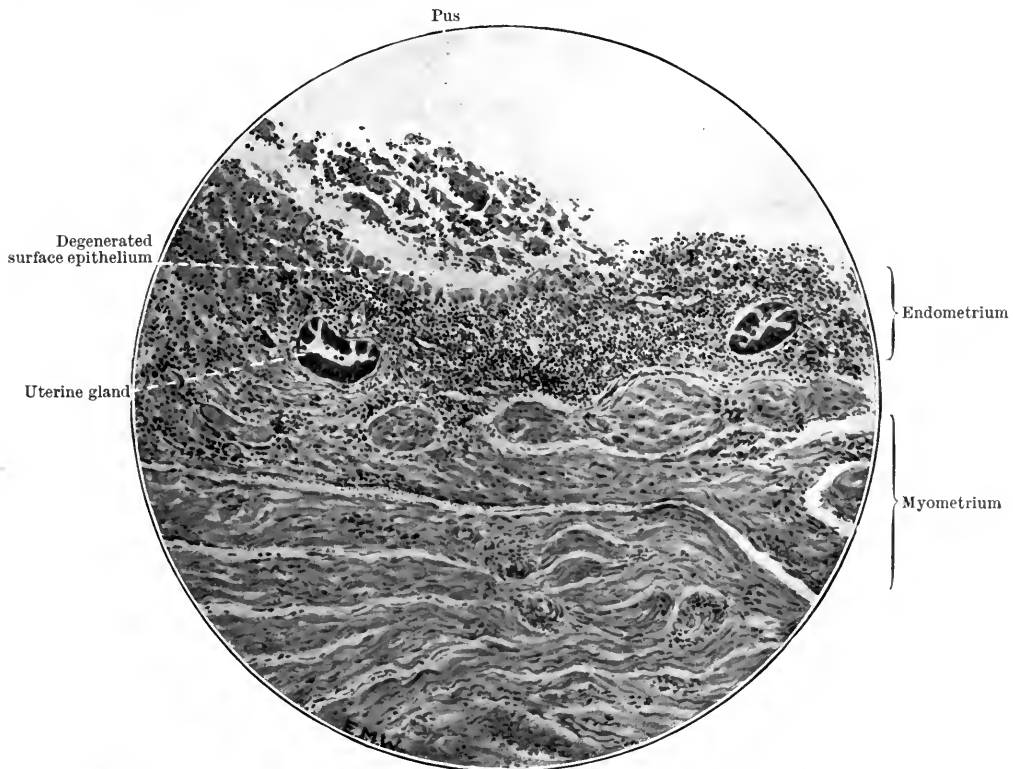


FIG. 250.—Microscopic section of inner surface of uterus from specimen of pyometra. The endometrium is narrow from stretching, and is infiltrated with leucocytes. Two glands as seen in cross-section and traces of surface-epithelium.

Treatment.—Free drainage of the uterine cavity through the cervix is the chief principle in treatment.

Cancer of the cervix should be curetted and cauterized. This will result in evacuation of the pus from the body of the uterus and in satisfactory drainage. Irrigation of the uterine cavity with saline solution, followed by the application of formalin in 10 per cent solution, is helpful by cleansing and disinfecting the parts.

In senile cases, when no new growth is found, opening up the cervix, which may be stenosed and may require incision, followed by irrigation and disinfection

of the uterus, usually ends in a satisfactory recovery, although hysterectomy may be necessary if the condition recurs.

Acute cases following the operations referred to above are best treated by intra-uterine irrigation with saline solution, given twice a day. The patient should sit up in bed to facilitate drainage. When this treatment fails, as is often the case, hysterectomy is called for and gives good results.

GONORRHOEA IN WOMEN

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Historical.—Gonorrhoea may be defined as a contagious disease, the result of infection by the gonococcus of Neisser. The disease has been known from time immemorial, and was described as early as the fifteenth century B.C. Indeed the chapters of Leviticus relating to Mosaic law lay down rules for the conduct of a man who “has an issue,” with regard to himself and his belongings, and can only refer to a venereal disease. It can also hardly be doubted that circumcision was first performed as a means of preventing inflammations of the prepuce, so often the result of a gonorrhoeal infection. The disease was not only known to the Jews, but was described by the Japanese, and was known to the Egyptians in the earliest times. Herodotus, 484 B.C., described a disease which might well be gonorrhoea. It was not, however, until the time of Hippocrates, and later of Celsus and Galen, that scientific treatises on the subject were written. Hippocrates thought that it was due to little tumours in the urethra, and that it was cured by a flow of pus from them. Celsus agreed with the views of Hippocrates, and also thought that ulceration of the urethra preceded the discharge. Galen was the inventor of the term gonorrhoea, because he believed the disease to be merely a flow of semen without an erection (A.D. 160). At this time prostitution was rife in the Roman empire, and venereal diseases abounded, so that the opportunities for studying their effects were plentiful. At the same time it is not clear that gonorrhoea was recognized to be a disease communicated by prostitutes. Later, in the fourth century, Paulus Aegineta, and in the tenth, Mesua and Avicenna described urethral discharges, and how to treat them, and the latter mentions washing out the bladder. In the Middle Ages much was written on the subject, and particularly on prophylaxis; washing with water, vinegar and water, or urine being recommended after intercourse. The contagious nature of gonorrhoea was insisted upon about this time, and regulations were framed for the

examination of prostitutes, and for the separation and treatment of any who were found to be suffering from gonorrhoea.

Early in the fifteenth century the first great epidemic of syphilis occurred, and then began the period of confusion between syphilis and gonorrhoea. Previous to this the two diseases had been regarded as distinct entities, but now writers commenced to express the opinion that gonorrhoea was but a manifestation of syphilis. Paracelsus seems to have been one of the first, if not the first, to express this opinion in 1530. Then began a long period of discussion in which many writers took part, some holding the view that the two diseases were distinct, others that gonorrhoea was a manifestation of syphilis. John Hunter took part in this discussion, and performed the experiment upon himself of inoculating pus from a supposed case of gonorrhoea, by means of punctures in the penis with a lancet. Hunter developed syphilis in consequence, and then came to the conclusion that syphilis developed from gonorrhoea! Whatever explanation is offered for the results of this experiment, it was singularly unfortunate, in that it delayed the progress of knowledge of venereal diseases for many years, and led to worse confusion. It was not until Ricord in 1831 showed conclusively as a result of numbers of experimental inoculations that gonorrhoea always *bred true*, and that syphilis never developed from gonorrhoea or gonorrhoea from syphilis, that the controversy was finally settled and the non-identity of the two diseases was established. Ricord also described the primary chancre of syphilis, and grouped the later symptoms into secondary and tertiary manifestations.

Even then a further controversy raged around the question as to the cause of gonorrhoea; was it a specific virus or was it due to simple irritation by a variety of causal factors? Although it was quite clear that of all irritants, gonorrhoeal pus was the one which could always be depended upon to produce a gonorrhoeal urethritis, the question of the actual cause was not definitely settled until Neisser discovered the gonococcus in 1879. In 1868 Salisbury, and in 1872 Hallier, foreshadowed the finding of the gonococcus by describing certain bodies in gonorrhoeal pus which were described as *spores* or as *micrococci*, and which Neisser eventually demonstrated clearly and named the gonococcus. Neisser demonstrated the gonococcus in urethritis in the male and in the female, and also in cases of ophthalmia. In 1882 Neisser showed that his previous views were correct, and also described how the gonococcus could be grown on artificial media in the laboratory.

The relationship of gonorrhoea to the female genital organs was not recognized, in its full importance, until the year 1872, when Noeggerath published a work on Gonorrhoea, with special reference to the diseases of women. Up to this time it

had not been recognized that gonorrhoea gave rise to lesions of the cervix, and the vagina alone was regarded as the part involved. Noeggerath brought out clearly the importance of the disease as a cause of inflammation of the uterus, appendages, and pelvic peritoneum. He showed that the disease may remain latent for long periods, during which the infected person is still capable of infecting others. Further, that a spread of the disease to the appendages can occur at a very long period after the initial infection. Sterility, too, was recognized by Noeggerath as a result of gonorrhoea, and also the possibility of puerperal sepsis occurring in a recently confined woman who had had the disease. Noeggerath somewhat exaggerated the incurability of gonorrhoea in the female, but in the main his observations were absolutely true, and it is only in regard to the details of pathological anatomy that anything has subsequently been added.

The Infecting Organism.¹—The gonococcus of Neisser is commonly seen in the form of diplococci rather larger than the common skin staphylococcus. The pairs of organisms are arranged in such a manner that they appear to have flattened or slightly concave surfaces in opposition, whilst the rest of the coccus is convex. This arrangement must be the result of active segmentation. Occasionally, as would be expected, four cocci are seen instead of two, the arrangement then being called a tetrad. The gonococcus as seen in films prepared from discharges, male or female, always occurs in or around polymorphonuclear leucocytes. The organisms are in the cytoplasm of the leucocytes, not in the nucleus. When a leucocyte becomes broken up in the process of making a film, the organisms are seen in a little scattered group not far from the remains of the nucleus. The gonococcus can be stained in a film by any aniline dye, the common one in use being carbolic methylene blue. Although the gonococcus has such specific microscopic appearances, it is useful to have a method of staining which will assist to distinguish it from other common micrococci. Thus whilst the common staphylococci and streptococci stain deeply by Gram's method, the gonococcus is decolorized. This fact is made use of to distinguish the gonococcus in a mixture of organisms. A film of the discharge to be examined is first stained by Gram's method and decolorized. It is then counter-stained by neutral red, when the gonococci appear bright red in colour whilst other cocci are a deep purple or violet. The same method will serve to distinguish the gonococcus in sections of tissues.

To prepare and stain a film of discharge suspected to contain gonococci, the following is the method in general use : a drop of discharge is taken up in a pipette

¹ See also Article on Micro-Organisms of the Genito-Urinary Tract (p. 97, and Plate III. p. 108).—EDITORS.

or upon a sterile swab and transferred to a clean glass slide, free from grease. The drop is evenly spread over the slide by running the edge of another slide along carrying the drop with it. The film thus made is allowed to dry in the air, and is then fixed by passing the slide through a Bunsen flame a few times. It is then ready for staining and will not wash off the slide. The film is first stained by Gram's method: aniline-water-gentian-violet for two minutes, then after washing off the stain with aniline water, Gram's iodine solution is poured on the film and left on for from thirty seconds to two minutes, according to the thickness of the film. The film is then decolorized by pouring on successive drops of absolute alcohol until no more stain comes out. As the gonococci are now decolorized, the film must be counter-stained in order that these organisms may be easily seen. The usual counterstain is neutral red, but fuchsin or Bismarck brown may be used.

The gonococcus is a difficult germ to cultivate artificially on laboratory media. It will not grow in ordinary agar, gelatine, or broth, but requires to have some animal fluid added. Thus at the present time blood-agar, or ovarian cyst-fluid agar, are the best media for artificial cultivation. It is best to inoculate tubes or Petri dishes containing these media direct from the patient. It does not do to take a swab from a patient, and then allow several hours to elapse before inoculating the media with it. This appears to suggest that cooling and perhaps drying of the organisms lead to their rapid death, and accounts for many of the failures to cultivate them. If however, there should happen to be a plentiful amount of discharge on a swab with a little blood as well, the organisms may remain alive for some hours, especially if they can be kept warm in the meantime. The colonies of gonococci appear round, flat, and rather greyish in colour on laboratory media. They grow much more slowly than the common staphylococci or streptococci, and consequently are difficult to separate from these organisms, with which the plates are apt to become overgrown. The difficulty of distinguishing the gonococcus from other organisms does not arise, however, in the case of Gram-positive micrococci. The staphylococci, the pyogenic streptococci, and some other cocci which are rarely found in the vagina and urethra are all stained positively by Gram's method, so that they are readily distinguished from gonococci which are left unstained.

There are, however, two organisms which are more difficult to distinguish from the gonococcus, namely the meningococcus, or, as it is fully named, the *diplococcus intracellularis meningitidis*, and the *micrococcus catarrhalis*. These two organisms are both Gram-negative, that is, are left unstained by Gram's method; consequently culture methods have to be relied upon to distinguish them from the gonococcus. In general the gonococcus is most difficult to cultivate on artificial media, requiring

always blood to be added to agar media or some artificial medium such as ascitic, hydrocele, or ovarian-fluid agar. On the other hand, the *micrococcus catarrhalis* grows freely on most media, including gelatin and broth, and produces no acid reaction with any of the sugar media. The meningococcus also grows more readily than the gonococcus on artificial media; it can be cultivated on plain nutrient agar, and produces an acid reaction with dextrose and maltose media. It is said that the gonococcus will only set up fermentation with production of an acid reaction in a dextrose medium, not in maltose. Both the meningococcus and the *micrococcus catarrhalis* are occasionally found in the urethra and the female genital organs, so that the distinction between these organisms is important.

In addition to the detection of the gonococcus in discharges and secretions there are two other methods of research which occasionally are of value in doubtful cases. In women especially, it not infrequently happens that the actual organism cannot be found in cases which clinically are gonorrhoeal. In such cases the complement-fixation test may be used, or the injection of a vaccine composed of dead gonococci may be made. The complement-fixation test is worked on the same lines as the Wassermann test for syphilis. The results obtained from it have not by any means been uniform, but sufficient work has been done upon it to show that a positive reaction is not usually obtained until after the disease has been in progress four weeks. Also it is clear that a positive result is of great value, whilst a negative one does not exclude gonorrhoea. Further, a positive reaction is obtained for some weeks after the disease has been apparently cured. The injection of a gonococcus-vaccine in a moderate dose usually produces a reaction in patients suffering from gonorrhoea. Thus increased urethral discharge, increased pain in affected joints, rise of temperature, as well as redness, swelling, and pain at the site of inoculation, have all been observed. On the other hand, a gonococcus-vaccine produces no reaction at all in a person who has not a focus of gonorrhoea.

Methods of Infection.—The only common method of infection is by means of sexual intercourse with a person already infected with the disease. It is, however, believed, both by medical men and the laity, that infection can occur from the seat of a water-closet, towels, bed-linen, garments, etc., and it must be admitted that this method is at least theoretically possible. Seeing, however, that the gonococcus is easily killed by cooling and drying, it would appear to be necessary that the infecting discharge must be still moist and recently deposited to be a source of danger to any one. This would mean a coincidence which could only occur very occasionally. Young children of both sexes are more often the victims of this kind of chance infection than adults, though even in young children, rape and precocious intercourse are only

too common sources of gonococcal diseases. Apart from infection of the generative organs it must not be overlooked that accidental infection of other parts of the body may occur, more particularly the eyes, the rectum, and the mouth.

Many cases of gonorrhoea arise as a result of inoculation from an infection which is *latent*. This means that the infected person either did not know that he or she had the disease at all, or believed that the disease was cured. In the male gonorrhoea may be *latent* up to a certain point, usually three or four years, but in the female the duration of the disease is quite indefinite. So much is the latter the case that some authorities have said that gonorrhoea is never cured in the female. This is without doubt going too far, and taking an unnecessarily pessimistic view, but it is an absolute fact that women have remained capable of infecting a man for many years. In the male the gonococcus may be harboured in the prostatic ducts, and can only be detected in the discharge obtained by massage of the prostate. In such cases there may be no gleet, and yet the man is capable of conveying infection to a woman. It is difficult to express an opinion as to whether a man is cured of gonorrhoea, but it is well-nigh impossible in the case of a woman. A man may usually be pronounced cured when there is no gleet, and no discharge containing gonococci can be massaged from the prostate. In the case of a woman the most careful examination of the cervix uteri, the vagina, the urethra, and of all the ducts opening into the vulva and urethra may fail to reveal the gonococcus, and yet the woman may be able to infect a man. The reason for this is that during sexual connection, secretions are dislodged from gland ducts in various situations which cannot be reached by any ordinary method of clinical investigation. In this way gonococci may make their appearance which have been growing undisturbed for years. Curious results sometimes occur in such cases; for instance, several men may have relations with the same woman on the same day, and only one man perhaps may become infected. It is not always the first man who is the victim, but this might certainly be expected. Coitus just after or during menstruation is more likely to cause infection than at other times, because the vaginal secretions then are not so acid and therefore allow living gonococci to be found in the vagina. Gonococci in the various glands and ducts opening into the urethra, cervix, vulva, etc., are not in any sense imprisoned, but grow undisturbed except during coitus. On the other hand, gonococci enclosed in a sealed Fallopian tube are practically imprisoned and consequently die out after a time.

Site of Inoculation.—There are two places in women where the gonococcus is likely to be deposited in sexual intercourse, and where in consequence the initial lesions commonly appear. These are the meatus urinarius and the cervix uteri.

The meatus is as a rule the first part with which the male organ comes in contact, and as slight pressure may be all that is necessary to squeeze out a drop of pus from the male urethra, inoculation may occur at once. The act of seminal emission, after penetration has occurred, deposits pus and semen upon and around the os uteri and actually in the cervical canal. In these two situations the folds, crypts, and glands present will form very suitable resting-places, where the gonococcus will find a favourable medium for its growth in an undisturbed state. Thus it happens that, in the early stages of gonorrhoea, the most important lesions are found in the urethra and in the canal of the cervix uteri. The vagina itself and the vulva are not easily inoculated, because in these situations the surface is covered by many layers of epithelium which resist infection, and also, especially in the case of the vulva, the organisms are dislodged by ordinary cleanliness. At the same time the orifices of Bartholin's ducts, and possibly of sweat and sebaceous glands, provide suitable breeding-places, and vulval lesions frequently start from them.

Effects of Gonococcal Infection.—The gonococcus produces a poisonous substance which is of the nature of an endotoxin. It is believed to be produced in the body of the organism itself, and to be set free by the death of the organism. The application of the toxin to the urethra, without the organisms, is said to produce a purulent discharge, and confers no immunity upon the urethral mucous membrane, as the same result follows repeated application.

The gonococcus, although normally an organism which lives on mucous membranes, is able to penetrate into the tissues and blood, and to give rise to metastatic affections. Thus a gonococcal septicaemia may arise, commonly with metastatic infection of joints, and sometimes of the heart, serous membranes, meninges, etc. In this respect gonorrhoea is a very serious disease, producing severe and prolonged illness and sometimes a fatal result.

In women particularly, gonorrhoea is a most serious disease, apart from gonococcal septicaemia, because of its far-reaching local effects, and its persistence in spite of treatment. It commonly spreads through the whole generative tract, leaving in its path inflammatory diseases of the vagina, uterus, Fallopian tubes, ovaries, and pelvic peritoneum, as well as of the urethra, bladder, and occasionally the ureters and kidneys. Apart from this widespread infection, the disease may remain localized in the cervix and urethra, giving rise to the condition which is known as "latent gonorrhoea," by means of which a female may communicate the disease to other persons for indefinite periods.

Methods of Clinical Investigation.—The investigation of a woman who is supposed to be infected with gonorrhoea is a difficult process, and requires a knowledge

both of accurate clinical methods and of laboratory technique. The lurking-places of the gonococcus are many; in the urethra it may be found in discharges pressed out by running the finger along the urethra from above downwards through the vagina, but in addition it must be remembered that there are numerous glands opening into the floor of the outer part of the urethra which may harbour the organism, in addition to Skene's tubes which are found on either side, opening at the meatus urinarius. It may then be necessary to examine the urethra with an endoscope, or a direct-vision urethroscope, so as to see these gland-orifices and obtain secretion from them direct. The openings of Skene's tubes, when inflamed, can be seen with the naked eye on either side of the meatus urinarius, when slightly opened up by means of a hairpin-retractor. Secretion may be squeezed from them, or a fine blunt-pointed hypodermic needle may be passed in for the purpose of obtaining secretion. Light scraping of the urethra with a small blunted curette may be employed to obtain secretion for examination. Again, secretion may be squeezed from Bartholin's glands by pressure with the thumb and forefinger, and collected with a platinum-wire loop for examination.

Turning to the vagina, in recent cases the vaginal discharge may contain gonococci, but as a rule the organisms are not found there. They are more likely to be found in the discharge from the cervix. The os uteri must be exposed with a speculum, and secretion may be obtained on a sterile swab (absorbent wool wrapped round the end of a wire) from the cervical canal, or the canal may be lightly scraped with a blunt curette, or secretion may be sucked up by means of a capillary pipette. Sometimes it is useful to place a sterile mop of absorbent wool in contact with the os uteri, after first cleansing it (without antiseptic), and then after twenty-four hours to remove the mop with the discharge upon it for examination. From all these situations, the secretion, however obtained, must be spread upon a clean glass slide free from grease. It should then be fixed by passing it three times through a Bunsen flame, and stained by Gram and neutral red. It is then ready for examination under a $\frac{1}{12}$ th oil-immersion lens. Nothing short of an elaborate and exhaustive investigation like this will serve to reveal the gonococcus in a case of long standing.

Local Lesions.—The two first local lesions observed are cervical catarrh and urethritis with vulvitis. The meatus urinarius is reddened and swollen, whilst the general surface of the vulva is reddened and bathed with secretion. It is not uncommon to find small excoriations of the inner side of the labia minora and fossa navicularis, with small shallow ulcers. The latter arise as papules or vesicles which afterwards lose their epidermal covering and form ulcers. It is questionable whether these small ulcers are the same as those described as *soft sores* or *soft*

chancres which are now looked upon as the result of infection by a specific organism, a bacillus named after Ducrey. They are not syphilitic, as was at one time believed, but may accompany either a gonorrhoeal or a syphilitic infection, and are always venereal in origin. The amount of swelling of the labia minora is variable, but in very acute cases there may be marked oedema, both of them and of the prepuce of the clitoris. The discharge is large in amount, and is commonly composed of the secretions of the inflamed cervical glands in addition to the discharge from the vulva itself. The cervix, as seen through a speculum, shows swelling of the mucous membrane at the os uteri and pouting folds bathed in secretion. It is vascular, and has a deep-red congested appearance contrasting markedly with the normal cervix. The discharge has most irritating characters and sets up a dermatitis of the perineal and vulval skin, often spreading to the gluteal folds and the inner sides of the thighs. After a time these acute lesions subside to some extent, and secondary lesions appear. These are vaginitis, papillomata of the vulva (gonorrhoeal warts), Bartholinitis, Skenitis, inflammation of the inguinal glands, occasionally abscess of the labium majus or minus, and peri-urethral abscess.

Vaginitis occurs as a result of desquamation of the epithelium under the influence of the irritative discharge and the gonococcus-toxin, after which the gonococci are able to invade the vaginal walls. The vagina then becomes intensely hyperaemic, and secretes a purulent discharge. Even at this stage, however, it is extremely difficult to find the gonococcus in the discharge, because so many extraneous organisms are present as secondary infections.

Gonorrhoeal warts may occur on any part of the vulva and surrounding skin of the thighs and gluteal region. They are the result of skin-irritation by the infective discharge, and are essentially papillomatous in structure. This consists of a central branching core of connective tissue covered by layers of epidermis. They vary in size from a pin's head to a large mass covering the whole vulva and projecting considerably from the surface. They may extend up the whole vaginal mucous membrane as far as the os uteri. They are bathed in discharge and secrete it themselves, and in consequence of their numberless folds, the discharge cannot escape and so undergoes decomposition. These warts may spontaneously disappear as the discharge becomes less, but they are apt to persist for a very long time if untreated.

Inflammation of the gland of Bartholin and its duct commences as a catarrhal inflammation of the orifice of the duct, and gradually spreads inwards to the gland itself. The swelling of the tissues around the orifice leads to mechanical closure, and consequently the increased gland-secretion cannot escape. As a

result the duct becomes gradually dilated and forms a cyst, and in some cases the gland itself becomes enlarged and cystic. According to the intensity of the inflammatory process the contents of the duct or gland may be simply glairy mucus, or may be purulent. In the latter case the condition is known as a Bartholin abscess. In some cases the duct gradually opens again as the inflammation subsides, in which case the retained secretions escape. In other instances organic adhesion at the orifice of the duct occurs so that permanent retention of the secretions results. In the chronic cases the orifice of the duct is surrounded by a red vascular area, just as it is in the acute condition. This has been called the "macula gonorrhoeica," and is usually regarded as pathognomonic of the disease.

Inflammation of Skene's tubes is a fertile source of *latent gonorrhoea*. The little ducts of Skene's glands, opening on either side of the meatus urinarius, not more than a centimetre deep as a rule, become inflamed, and having very small orifices are apt to harbour the gonococcus for indefinite periods. The orifices show as small red points just inside the urethral labia on each side. Pus can be squeezed from them, and a fine probe or blunt-pointed hypodermic needle can be passed into them.

Peri-urethral abscess in a similar manner is the result of gonococcal infection of the ducts of the glands in the floor of the urethra, which are the homologues of the male prostate. Their orifices can only be seen by means of the urethroscope. Abscess results when the gland-orifices become closed, and suppuration occurs as a consequence of the severity of the inflammation in the glands. A swelling surrounding the lower surface of the urethra can be felt from the vagina. If large it may obviously fluctuate; sometimes pus can be squeezed from it into the urethra, showing that the duct and its orifice are still pervious.

Inflammation and swelling of the *inguinal glands* almost always accompanies any form of acute gonorrhoeal vulvitis. It is peculiarly likely to occur when there is excoriation, or when small ulcers form on the vulva. Septic absorption along the lymphatic channels is the essential cause of the lesion. The superficial glands of the groin are usually involved, but the deep series are often inflamed as well. They not infrequently suppurate, forming very troublesome abscesses, the "gonorrhoeal buboes."

Abscess of the labia occurs when there is a virulent infection, accompanied by secondary infective organisms from the skin. It is usually the result of lymphatic absorption becoming arrested in the labium, instead of spreading to the inguinal glands, although the glands may be involved as well.

All these lesions are essential concomitants of acute gonorrhoea, and although they are troublesome enough, painful and prolonged, yet they cannot be regarded

as of such serious import as the lesions yet to be described due to the upward spread of the infection to the uterus and Fallopian tubes (see Complications).

Symptoms of Acute Gonorrhoea.—These usually come on within about three days of the initial infection, and not infrequently urethral discomfort is the first. Pain of a scalding nature on passing water is first complained of, and either with it or very soon after its appearance a discharge commences. This is often rather thin and semipurulent, highly irritating, and causing soreness of the vulva and thighs. It comes chiefly from the cervix, but the vulva adds to it. Walking becomes exceedingly painful owing to the excoriation of the skin of the thighs. Any ulcers of the vulva which may occur are very sensitive and painful; the swollen hymeneal remnants are so painful as to make even the introduction of a finger impossible. There is pain on defaecation, on sitting down, or rising up; in fact pain on any movement is the rule. Naturally the degree of pain varies, and it is a fact that in many cases the symptoms are not sufficiently severe to make the patient call in a doctor. When the acute symptoms subside, usually in about a week or ten days, either nothing but the discharge persists, with perhaps a little scalding micturition, or secondary symptoms arise due to the infection of Bartholin's glands and the inguinal glands, or the formation of superficial ulcers or warts. Pain in each case is the chief symptom, with great irritation in the case of warts.

Treatment of Acute Gonorrhoea.—The treatment must be regarded as very unsatisfactory in the most acute stages, partly because they are seldom seen, but chiefly because the parts are so sensitive and painful that only the mildest form of treatment can be tolerated. As a general rule, all that can be done is to order a mildly antiseptic vaginal douche such as 1 in 4000 permanganate of potassium, hot sitz-baths and frequent washing or syringing of the vulva. The labia may be kept apart by a piece of lint thickly smeared with an ointment composed of calomel gr. xxx to the ounce of vaseline and lanoline, equal parts. This must be changed frequently so as to prevent decomposition. In addition the labia and thighs should be kept as dry as possible, using a dusting powder of calomel, bismuth, and starch. Any form of active local treatment at this stage for the cervix or urethra would have to be carried out under an anaesthetic as the parts are so sensitive.

However, when the acute symptoms have somewhat subsided, active treatment should be carried out. The cervix uteri should be exposed with a speculum and swabbed out with an efficient antiseptic. Those in general use are pure carbolic acid (liquid), tincture of iodine, or argyrol 20 per cent solution. If dilatation of the cervix is necessary to do this, it may be necessary to give an anaesthetic, though some degree of insensitiveness may be produced by introducing a strip of

gauze soaked in cocaine or novocain solution. In the same way it is usually recommended to irrigate the urethra, from behind forwards, with permanganate solution, and to swab it out with 20 per cent argyrol. Soluble vaginal suppositories containing iodoform, or bougies for the urethra are recommended after the swabbing operation. As regards general treatment, the patient should remain in bed during the acute stage, abstaining from alcohol or any highly stimulating diet. Daily saline purgatives should be given, and some medicine containing citrate of potassium and tincture of hyoscyamus is useful to keep the urine as unirritating as possible.

Warts will in some cases disappear under antiseptic vaginal douches. In the sub-acute stages when warts are present, a more powerful antiseptic douche may be given, such as tincture of iodine (5i ad Oi). If, however, they do not diminish but remain stationary, applications of pure carbolic, picric acid in alcohol (saturated solution), or pure nitric acid should be made, in the case of carbolic and nitric acid taking care not to burn the surrounding skin. Twice a week is often sufficient, but there is no harm in touching them every day. Large masses of warts are best excised, when the discharge has been controlled and is no longer irritating.

Inflamed Bartholin's glands are treated by antiseptic vaginal douches and hot fomentations to the vulva. Under this treatment the gland-orifices may open up and the secretions discharge. If, however, an abscess or chronic cyst develops, the best plan is to excise the whole gland and duct, draining the small cavity thus produced for a day or two, as it is very difficult to keep such a cavity aseptic.

Inflamed inguinal glands will sometimes subside spontaneously or with the use of hot fomentations. If abscesses form they must be opened and drained. Not infrequently these lead to the formation of long-standing sinuses, in which case the best treatment is to dissect out the sinus and all the glands involved.

In some cases a vaccine, made from several strains of the gonococci of different individuals, will assist the resisting powers of the patient and hurry the healing process. The results obtained from the use of vaccines in gonorrhoea are uncertain, but there is no doubt that they often produce wonderful results. They should be given in small doses at first, because they are apt to set up a marked febrile reaction, during which the patient feels very ill. It is highly probable that vaccines, given in judicious doses at the right times, will prove to be the best means of preventing the upward spread of gonorrhoea, as well as being a means of cutting short the acute stage and preventing complications. It is commonly regarded as unnecessary to prepare an autogenous vaccine, partly because it has been found in practice that a 'stock' gonococcus-vaccine, made from several strains of organisms (from different individuals), produces results which are as good as those

commonly produced by autogenous vaccines in other diseases. Another reason urged against autogenous vaccines is the great difficulty of cultivating the gonococcus directly from an individual case. In any case the first dose should not be more than two millions, and the time to give the second dose must be judged by the presence or absence of a reaction. With a small dose, however, a reaction very seldom occurs sufficient to cause a rise of temperature. If too large a dose is given at first, the patient feels tired and worn out in about twelve hours, has a rise of temperature, and an occasional patient will have a rigor. In addition the vaginal or urethral discharge will be increased and all the local symptoms will be worse. Such an effect from a vaccine is always to be avoided if possible. If no reaction follows the first dose of two millions, the second dose of five millions can be given in five days' time, and after that the doses may be increased to ten millions and twenty-five millions at intervals of a week. If a marked reaction follows any increased dose, the next one should not be further increased. It does not follow that the doses should be increased at all, the point to aim at being the smallest dose which will produce a beneficial effect. If steady benefit follows repeated doses of five or ten millions, there is no necessity to increase the dose at all. No absolutely definite directions can be laid down as to dosage; every case must be treated on its merits. It need hardly be said that every dose of vaccine should be given with a freshly-boiled hypodermic syringe and needle. The site of inoculation is usually the abdominal wall, but for convenience other situations may be chosen, such as the deltoid region, just below the clavicle or above the great trochanter. In any situation it is best to inject the vaccine intramuscularly.

It must be clearly recognized that acute gonorrhoea should be treated as energetically as possible in the early stages. It is only by doing this that the upward spread of infection to the uterus and Fallopian tubes can be prevented. It is often a matter of great difficulty to decide whether the disease is cured, and it is only by a patient investigation, such as will be described under latent gonorrhoea, that this point can be determined. In the case of a married woman, cohabitation with the husband must be forbidden until it can be demonstrated that the disease is cured. A cure can only be regarded as accomplished when all symptoms have ceased, and when gonococci can no longer be demonstrated in the discharge from all the well-known lurking-places of the organism. The disease may be kept up indefinitely if the husband be infected, for he may then reinfect the wife and thus establish a vicious circle from which there is no escape for either party, without complete separation until both are symptomatically and bacteriologically cured.

Latent Gonorrhoea.—It not infrequently happens that a woman who has passed

through the acute and chronic stages of gonorrhoea still remains infectious, in the sense that she is able to infect a man through sexual connection. She may have no very obvious symptoms except a vaginal discharge, which in itself has no special characters. In such a case it is important to find out if possible where the specific organisms are lodged, and this may involve a very difficult investigation. Remembering the common places in which gonococci are to be found, namely the Bartholin glands, the urethra, the glands in relation to the urethra and the cervix uteri, the investigation must be so carried out that all those places are thoroughly examined for the presence of the organism. Specimens of discharge obtained from these places should be carefully numbered, so that if gonococci are found in any one of them, there may be no possible confusion as to the source. When the source has been discovered the appropriate local treatment for its disinfection can be carried out. The most difficult sites to disinfect are Bartholin's glands and the urethral glands. In the case of the former complete excision of the gland is probably the only satisfactory way of getting rid of gonococci. Suppurating Skene's tubes are best dealt with by complete destruction with a fine-pointed electro-cautery, whilst in the case of the glands opening on the floor of the urethra, destruction by means of the electro-cautery through a urethral speculum or urethroscope is the best means of cure. Swabbing out the urethra with argyrol, protargol, or nitrate of silver may be efficacious in some cases, but will not cure if the organisms are deeply seated in the glands.

Chronic gonococcal cervicitis is characterized by the same appearances at the os uteri as those seen in other infections. That is to say, there will be hypertrophy of the cervix from chronic areolar hyperplasia, overgrowth of the mucous membrane of the cervix, and replacement of the epithelium on the vaginal surface of the os uteri by hypertrophied mucous membrane. The appearance at the os uteri is that of an 'erosion,' with a granular, bright-red surface contrasting markedly with the smooth vaginal epithelium. A microscopic section of an 'erosion' shows numbers of branching glands like those of the cervical canal, lined by long columnar epithelium, replacing the normal vaginal epithelium. The surface is often irregular and thrown into folds producing a papillary appearance, whilst cystic dilatations of the glands beneath the surface produce the well-known 'ovula Nabothi.'

The *symptoms* of a chronic gonorrhoeal cervicitis and 'erosion' are backache (sacralgia) and leucorrhoea. The discharge is opaque, thick, and tenacious, and contains numbers of leucocytes and desquamated epithelial cells. It is very rarely possible to find the gonococcus in the discharge, but light scraping of the canal with a curette may reveal leucocytes containing the organisms. The cervical

canal is always plugged with a thick mass of mucus, which is very difficult to dislodge. It will be noted that menstruation is unaffected, unless the infection has spread up to the body of the uterus, in which case there will be menorrhagia.

The *diagnostic features of an erosion* are: A soft velvety surface, beneath which the tissues are dense, leathery, and tough. Bleeding may be caused by rough manipulation, but this bleeding is never elicited with the light touch which will start it in a cancer of cervix. Further there is never the friability which characterizes a malignant growth.

The *treatment* is difficult and apt to be disappointing. The difficulty arises because the infection is so deeply situated in the glands and crypts of the cervical canal, and cannot be reached by ordinary applications. It is generally quite useless to remove the cervical mucous membrane with the curette, because it is impossible to remove the whole of the infection in that way, short of removing the whole lining down to the muscle-layers. This, naturally, must not be done because it would lead to cicatricial stenosis of the canal, if not to actual closure. The usual treatment is to apply strong antiseptic or caustic drugs to the erosion and to the cervical canal by means of probes thinly coated with absorbent wool. The best of these drugs is saturated solution of picric acid in alcohol, but iodized phenol (one part of iodine in five parts of liquid carbolic acid), tincture of iodine, and 25 per cent argyrol are often used. In any case it is important to remove the plug of mucus first, by swabbing the cervical canal with liquor potassae diluted four times. At least two coated probes should be used each time, and the drug must be well rubbed into the cervical canal as high as the internal os, but no higher. The application must be made with the cervix thoroughly exposed by a speculum in the vagina, once a week being the usual interval. If a decided improvement is not seen in six applications, it is useless to repeat the process. It is, however, generally found that the best results are obtained by using a vaccine composed of a stock gonococcus, combined with an autogenous vaccine prepared from any extraneous organisms of a pathogenic nature, which can be grown from a swab taken from the cervical canal. Vaccine treatment should always be combined with local applications, and daily douches of an astringent, such as alum, to keep the vagina washed free of discharge. When chronic gonorrhoeal cervicitis is combined with a true vaginitis, the whole vagina should be swabbed out with tincture of iodine when the cervical lesion shows signs of improvement, so as to disinfect it as completely as possible. This can usually be done without an anaesthetic when the lesion is really chronic. In the worst cases, which are very resistant to treatment, the only available means is high amputation of the cervix, combined with disinfection of the whole endometrium

after dilatation and curettage, and uniting the mucous membrane to the cut edge of the vaginal surface.

Complications of Gonorrhoea.—The commonest complication is the upward spread of the infection to the body of the uterus, and then to the Fallopian tubes. The gonococcus is an organism which is particularly able to infect and grow on columnar epithelium, so that there is no difficulty in understanding how it may spread along the continuity of the mucous membrane of the uterus and Fallopian tubes. The time taken to spread from the cervix is variable, but cases have been recorded where acute salpingitis has occurred as early as two weeks after the initial infection. This is quite exceptional, for although cases may occur a month or six weeks after infection, more often several months elapse before signs of salpingitis appear. Although it cannot be foretold in which cases the infection will spread upwards, yet it is quite clear that if infection occurs to a pregnant woman a few weeks before delivery, or soon after delivery, the results are more likely to be severe, and upward spreading is almost certain to occur. The same applies to infection during or just before menstruation, but not quite in the same serious degree. In many cases the infection remains absolutely localized to the cervix, the body of the uterus never becoming infected. The signs of infection of the endometrium are by no means distinct, and it not infrequently happens that the first intimation of upward spreading is an attack of acute pelvic peritonitis. This cannot occur until the organisms have spread through the Fallopian tubes to the abdominal ostium. In other cases there are more evident signs of acute inflammation of the endometrium (see "Septic Infections," p. 561), and later those associated with acute salpingitis. It is not, however, until the pelvic peritoneum becomes infected that any very acute illness occurs; patients with acute endometritis and salpingitis alone are more often able to be up and about. In this respect, of course, gonorrhoeal infections of the uterus and tubes are quite unlike those due to puerperal infections.

When once the Fallopian tubes are involved, the anatomical results are the same as in salpingitis caused by any other infecting organism. The mucous membrane is first involved, but the muscular coats always become affected to some extent. As a result the lesion may be either a catarrhal or an interstitial salpingitis. If the first is in excess and the abdominal ostium is closed, inflammatory products distend the tube, forming a hydrosalpinx or a pyosalpinx. If the second is more marked the tube-wall is thickened, sometimes enormously so, without any marked dilatation of the lumen.

The involvement of the pelvic peritoneum at first produces a large fluid exudate,

which later coagulates, and becomes more or less organized. In this way adhesions form between the Fallopian tubes and all adjacent structures.

The ovary is always involved when the peritoneum becomes infected, an oöphoritis resulting. At first superficial, the inflammation may spread deeply into the stroma of the ovary, often through the medium of a recently-ruptured Graafian follicle. The ovary thus becomes swollen and hyperaemic, surrounded by adhesions, and eventually sclerotic and fibrous on the surface. During this process an open Graafian follicle may become attached to the abdominal ostium of the tube so that their cavities communicate. When this cavity enlarges by accumulation of inflammatory products, a tubo-ovarian cyst or abscess results, according as the contents are watery or purulent.

Repeated attacks of pelvic peritonitis may occur at long or short intervals in cases of gonorrhoeal salpingo-oöphoritis. The explanation of these is not always clear, for if the tubes become closed at the first attack, it is hardly possible for further infection to occur through them. It is more likely that the subsequent attacks are the result of other organisms than the gonococcus, for instance the *bacillus coli communis*, which may find its way to the pelvic peritoneum through the wall of an already adherent piece of bowel.

Thus it is clear that the effects of gonococcal salpingo-oöphoritis are extremely widespread, give rise to serious illness, and may reduce the patients to years of invalidism. The details of the anatomical results, symptoms, and treatment of these conditions will be found under the heading of salpingo-oöphoritis and pelvic inflammation.¹

Gonococcal General Peritonitis.—Although diffuse peritonitis of gonococcal origin is a rare condition, a considerable number of cases have now been seen and described. In any case, the gonococcal origin can only be established by finding the organism in the peritoneal exudate. It has been seen in quite young children as well as in adults. In the former the initial lesion was usually a vulvo-vaginitis, whilst in the latter gonococcal salpingo-oöphoritis was present. It is much more common in women than in men. It has been known to follow upon operations for the removal of Fallopian tubes and ovaries infected with the gonococcus. The onset of the disease is very sudden—acute pain, abdominal rigidity and distension, with vomiting, rise of temperature, and a quick pulse are the initial signs. These signs are the same as those seen in local peritonitis, and the distinction between the two conditions is very difficult. The symptoms are not nearly so severe as those seen in diffuse peritonitis due to other organisms.

¹ Article on Inflammatory Affections of the Fallopian Tubes (p. 623).

As general peritonitis is a rare complication of gonorrhoea, the indications for treatment are not often very clear. It is a fact, however, that the disease has sometimes cleared up spontaneously, and that operations, therefore, are not always required. In any case in which the symptoms are severe, and in which it is clear that the peritoneal infection is general, there is no doubt that an immediate laparotomy would be the most likely treatment to ensure the patient's safety. The condition of the appendages could then be observed, and the tubes could be removed if obviously infected. Drainage should always be employed, both through the posterior vaginal fornix and through each loin just above the crest of the ilium. If the patient is then placed in the Fowler position, and continuous rectal saline infusion is carried out, there is a good prospect of recovery. It will be seen that this is the same as the modern method of treating all forms of acute general peritonitis.

Gonococcal Septicaemia.—Under some conditions cases of acute illness occur in which the gonococcus can be found in the circulating blood. These are always secondary to a primary gonorrhoeal infection of the urethra, cervix, or conjunctiva, and although it is not known why in some cases the organisms enter the bloodstream and not in the majority, yet it is believed that traumatism in some way predisposes to it. Further, although in some cases the disease is a pure gonococcal septicaemia, in others a mixed infection may be present, such as that due to a streptococcus along with the gonococcus. The signs of a gonococcal septicaemia are the same as those due to the streptococcus or other organisms. The disease may be fatal in itself, but death is more often due to the metastatic lesions which occur. The most important of these are endocarditis, pericarditis, arthritis, periostitis, pleurisy, pneumonia, pyelitis. Although other organs or tissues may be involved, such as the skin, the tendon-sheaths, the parotid gland, nerves, and muscles, they occur less frequently than the above lesions of the serous membranes, lungs, and kidneys.

The most common manifestation of gonococcal septicaemia is *arthritis*, and although it may occur in the course of a severe febrile illness, it more often shows itself when the primary lesion is in a chronic condition, and is not accompanied by severe general symptoms. In rather less than half the cases only one joint is involved, and the joint most commonly affected is the knee, the next in order of frequency being the ankle, wrist, elbow, shoulder, and small joints of the hand or foot. The illness generally begins with pain in several joints accompanied by a moderate degree of fever. After a time the pain is localized to one or more joints, leaving the majority unaffected. Sometimes the lesion takes the form of a synovitis with accumulation of fluid in the joint, sometimes the ligaments are more affected. Ankylosis not infrequently follows and suppuration of the joint may occur. The

duration of the acute stage is variable but may last three or four weeks. Some cases are free from acute symptoms from the very commencement; in these the duration is very indefinite. In these chronic cases it is difficult to demonstrate that the lesion is a septicaemia at all, but the organisms must find their way to the joints *via* the blood-stream, so that there must be a septicaemia present of a mild type.

The *diagnosis* of gonorrhoeal arthritis is not always easy, especially if the local lesion, urethritis, or cervicitis, cannot be proved to be gonococcal. The history of the case, the peculiar joints sometimes involved, the duration and tendency to relapse, and absence of sweating, combined with the history of a discharge having a sudden onset, usually point to the nature of the lesion and serve to distinguish it from acute rheumatism.

The *treatment* of gonorrhoeal arthritis can only be briefly indicated here. Rest in the acute stages; fixing the joints affected on splints; massage, and passive movements when the case becomes chronic; combined with tonic drugs, good feeding, and above all gonococcal vaccines, must be the basis of all treatment. The vaccine used need not be an autogenous one, as a stock gonococcus-vaccine, made from several strains of the organism, seems to answer just as well as an autogenous vaccine. The results of vaccine treatment of gonorrhoeal arthritis are very encouraging, better in fact than those of similar treatment applied to the primary lesions.

Extra-Genital Gonorrhoea.—*Urethritis* has already been mentioned. From the urethra the infection is liable to spread to the bladder, either by direct continuity or by the unwise use of catheters or the cystoscope during an acute attack of urethritis. The part usually infected is the trigone of the bladder, the whole mucous membrane being seldom involved.

The diagnosis of gonorrhoeal *cystitis* depends upon finding the organism in the urine, combined with the classical symptoms of cystitis. Frequency of micturition, painful micturition, general feeling of weight and discomfort in the pelvis, and sometimes rectal tenesmus make up the usual combination of symptoms. Involvement of the trigone alone is particularly likely to be a gonorrhoeal lesion. The treatment is that of cystitis in general, assisted by a stock gonococcus-vaccine.

Pyelitis, due to gonorrhoea, is a rare affection. It may occur in the course of a septicaemia, in which case the organisms reach the pelvis of the kidney and enter through the blood-stream. In other cases the infection is an ascending one from the trigone of the bladder. The symptoms and treatment are the same as those of the common form of pyelitis.

Gonorrhoeal ophthalmia may occur in the newly-born or in adults. In the former, infection occurs during the passage of the foetal head through the infected

birth-canal, and the lesion appears within the first three days. It is essentially a conjunctivitis to begin with, spreading thence to the cornea and sometimes to the whole eye-ball. Ulceration of the cornea is common, leading to opacities, cataract, adhesion of the iris to the lens, etc. It is thus a fertile source, in fact the most common, of blindness from birth.

Gonorrhoeal ophthalmia may be *prevented* by careful cleansing of the eyelids as soon as the baby's head is born, before the eyes are opened, with a saturated solution of boric acid, then dropping into each eye two drops of a 1·5 per cent solution of silver nitrate. Other antiseptics, such as perchloride of mercury, protargol, argyrol, etc., have been tried for this purpose, but nothing has yet been discovered which acts so well as silver nitrate.

The principles of treatment are: repeated washing out of the conjunctival sac with boric acid or saline solution, every hour or even half-hourly in a severe case, combined with delicate swabbing of the lids inside, with a 1 or 2 per cent solution of nitrate of silver followed by saline solution. Once a day is usually sufficient for the nitrate of silver application. Argyrol, 25 per cent solution, is sometimes used instead of the silver nitrate. It has to be used more often, and on the whole is not so good as the silver nitrate.

Gonorrhoeal ophthalmia in adults is always the result of an accidental inoculation. It runs the same course as in an infant, but may be very severe and lead to blindness.

Gonorrhoeal stomatitis and *rhinitis* have been described both in children and in adults. They may occur as accidental inoculations or may accompany a gonococcal septicaemia.

Proctitis.—The anal canal occasionally becomes infected by gonococci, either as a result of accidental inoculation from vaginal discharge being rubbed into the anus, or by the practice of unnatural offences. It is an inflammation of the lowest three inches of the rectum and anus, sometimes accompanied by small ulcers and always by an eczematous condition of the skin around the anus. Not infrequently there is a single fissure at the anus, and gonorrhoeal warts may be present.

It is apt to become a chronic affection, and to lead to stricture of the rectum as a result of perirectal inflammatory changes.

Only the simplest rectal injections can be used in the acute stage, on account of the pain, which is a marked symptom. When the disease has become more chronic, local treatment through a small rectoscope or speculum may be employed. For this purpose the bowel must be washed clean, and then swabbed in the affected area with argyrol solution or 1 per cent nitrate of silver.

If a stricture forms, it must be gradually dilated with rectal bougies, preferably through a speculum if not quite central or complicated in any way.

Gonorrhoea in Children.—Vulvo-vaginitis in little girls is comparatively frequently due to gonococcal infection. It is impossible to say with what frequency it occurs, but Kelly and Noble quote 63 per cent of all cases of vulvitis in children as being gonococcal, as described by Hurdon at the Johns Hopkins Hospital Dispensary. Other authorities give various figures, showing easily-understood discrepancies when the practical difficulty of finding the gonococcus in discharges is realized. It is apt to occur in epidemics, several of which have been described. The infection may be brought about by accidental inoculation from infected towels, napkins, underclothes, bath water, and water-closet seats; sometimes, too, by precocious intercourse and attempts at rape.

The parts affected are usually the vulva and vagina, sometimes only the former. It is comparatively rare for the cervix or uterus to be involved. The vaginal walls are much more easily infected in children than in adults, owing to the thinness and undeveloped character of the vaginal mucous membrane.

Symptoms.—The discharge is yellow or yellowish-green in colour, irritating in character, and leads to redness of the whole vulva and of the skin of the thighs and buttocks. Small excoriations may occur and warts are sometimes seen.

Pain is usually complained of, especially on micturition, and on account of this, retention of urine sometimes occurs. Some pyrexia may be present during the acute stage, but many cases are afebrile and sub-acute from the start.

The *diagnosis* can only be made by the recognition of the gonococcus in the discharge, simple enough at the first onset, but sometimes impossible when the lesions have become chronic.

The *treatment* is unsatisfactory owing to the difficulty of carrying out effective douching and local applications in young children. In some cases simple local applications to the vulva are sufficient, but when the vagina is involved it must be treated by douches, and local applications of nitrate of silver (1 per cent) or argyrol (20 per cent). Simple sterile water, salt solution, or weak permanganate solution may be used for douching. The strictest precautions must be taken to isolate any child who suffers from the disease. In institutions or homes where there are several little girls the disease is very easily carried from one to the other unless the strictest precautions are taken.

TUBERCULOSIS OF THE FEMALE GENERATIVE ORGANS

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GENERAL PATHOLOGY

TUBERCULOSIS of any tissue is due to its invasion by the tubercle bacillus discovered by Robert Koch in 1882. It is a non-motile rod .003 mm. long. It is difficult to grow artificially, but can be grown slowly on blood-serum where a visible growth only occurs at the end of about ten days, or on special media which have been elaborated in the last few years, on which it is possible to get a growth in about seventy-two hours. The diagnosis of the presence of the tubercle bacillus is made by staining a film made from the pus, etc., in the following way. After the film has been fixed, hot carbol-fuchsin is poured on and left for five minutes. The film is then immersed in 25 per cent sulphuric acid till colourless, and then washed in tap-water. If the film has still got more than a greyish-red colour it should be put back in the sulphuric acid till this tint is obtained after washing. The film is then counter-stained with a solution of methylene blue for one minute, then thoroughly washed and dried. Any tubercle bacilli present will be stained bright red, the other bacteria, pus cells, etc., will be stained blue (see Plate II. p. 107).

The only other organism that may give rise to difficulty is the *smegma bacillus* which is found on the external genitalia and especially in the interlabial fold. It can be differentiated from the tubercle bacillus in that after staining with hot carbol-fuchsin it is easily decolorized by means of alcohol. The two processes of decolorization may be carried out simultaneously by immersing the film (after staining with carbol-fuchsin) in 3 per cent hydrochloric acid in absolute alcohol, when the *smegma bacillus* becomes decolorized while the tubercle bacillus remains red.

After tubercle bacilli gain access to the tissues they induce proliferation of the endothelial cells of the lymphatics and connective-tissue spaces. These cells somewhat resemble epithelial cells and are called *epithelioid* cells. After a time a *giant-cell*

system is formed, in the centre of which is a large giant-cell containing numerous small deeply-staining nuclei arranged radially round the periphery of the cell. The centre of the cell is frequently necrotic. This giant-cell is an epithelioid cell that has undergone nuclear division; surrounding it are a large number of epithelioid cells arranged radially, and outside are connective-tissue cells and lymphocytes.

At a later stage macroscopic changes can be seen in the tissue; these consist in the presence of yellowish-grey nodules about the size of a pin's head. These nodules are formed by the growth and fusion of the giant-cell systems described above, and are called "tubercles." They tend to become avascular and necrotic; frequently other bacteria give rise to a secondary infection and cause a more rapid breaking down of the tissue.

Tubercle bacilli are not very abundant in tuberculous lesions in man; they are chiefly extra-cellular, but a few occur inside the giant and epithelioid cells. In tuberculous endometritis, however, they are more numerous.

Owing to the difficulty of demonstrating the organism in sections of the affected tissue, it is usual to inoculate a susceptible animal such as the guinea-pig. An emulsion of the affected tissue is made in normal saline and is injected subcutaneously in the region of the knee-joint of a guinea-pig. If the tissue is tuberculous, a gradually ascending invasion of the lymph-glands occurs, followed by general miliary tuberculosis. The rate at which this takes place varies considerably, but usually a diagnosis can be made within three weeks.

It is sometimes possible to demonstrate the tubercle bacilli in discharges or tissues by treating them with antiformin. This destroys everything except tubercle and other acid-fast bacilli, so that after such treatment and dilution, the bacilli can be separated by centrifugalization and stained in the ordinary way.

It is often difficult to state that any given lesion is tuberculous from its physical signs. The demonstration of the bacilli in the discharges is difficult, and animal inoculation means the loss of several weeks before a result is obtained. Because of these difficulties, other tests have been devised to help diagnosis, such as the subcutaneous inoculation of Koch's old tuberculin, the cutaneous inoculation of von Pirquet, and the conjunctival inoculation of Calmette. The reactions provoked by these methods depend on the hypersensitiveness of the tissues to tuberculin. Such hypersensitiveness depends on the previous invasion of the tissues by the tubercle bacillus. But seeing that 90 per cent of people have a tuberculous focus somewhere in the body, and since the hypersensitiveness may remain for a long period after the lesion produced by the bacillary invasion has completely healed, it follows

that too much reliance should not be placed on these reactions for the diagnosis of active lesions. If, however, the use of a subcutaneous injection is followed by pelvic symptoms such as bearing-down pain, tenderness, and even uterine haemorrhage, it is very suggestive of a local pelvic tuberculous focus. Birnbaum and Prochownick report favourably on the use of this test.¹

Frequency.—Tuberculosis of the genital tract exists more frequently than was once thought to be the case, as it often causes no characteristic symptoms, and so its nature is only found out after operation—the so-called “unsuspected tuberculosis” of Whitridge Williams. Statistics have been published² which show that in autopsies on women dying of general diseases, about 1 per cent show signs of genital tuberculosis; of women dying of phthisis and other forms of tuberculosis, about 5 per cent show lesions. Of greater interest is the fact that actually in some 10 per cent of all cases of salpingitis, the tubes are found to show signs of tuberculosis, with or without secondary infection. The figures given by different observers vary, because many cases need prolonged investigation before definite proof of tuberculosis can be obtained. For the same reason these percentages are much higher than those given at the bed-side or operating-theatre, where a diagnosis of tuberculosis of any of the generative organs is rarely made. But the fact that laborious laboratory research has demonstrated the presence of old or recent tuberculous lesions, in a proportion of cases that is so very much higher than that recognized clinically or at operation, deserves the fullest attention of the operator.

Etiology.—*Age.*—The average age of the patient varies to some extent with the particular viscus affected, but it is essentially a disease of the child-bearing age. The majority of cases occur between the fifteenth and twenty-fifth years. Before puberty it is uncommon, although vulval lesions are occasionally found in children; after the menopause it is rare.

Congenital Maldevelopment.—It has been noted that an unusually large proportion of tuberculous organs (especially tubes) are poorly developed and infantile in character. This may be due to congenital maldevelopment, but an alternative explanation is, that it is due to the loss of the secretion of the corpora lutea, etc., in cases in which ovarian sclerosis has occurred.³

Co-existence with other Types of Infection.—Tuberculosis may occur in organs which have previously been inflamed, and even more frequently, a tuberculous tube

¹ See Bandelier and Roepke, *Lehrbuch der spezifischen Diagnostik und Therapie der Tuberkulose*.

² For references see André Rives, *La Tuberculose des annexes de l'utérus*. Thèse, Montpellier. Published by Firmin Montane et Sicardi, Montpellier, 1909, pp. 9-11; also Bondy, *Wiener klinische Wochenschrift*, 1911, No. 27, p. 979.

³ Poncet and Leriche, *Lyon Médical*, July 1911, p. 57.

may become secondarily infected by bacillus coli from the bowel or appendix, so that the tuberculous origin of the disease is masked.

Co-existence with New Growths.—An unusually large proportion of cases are complicated by the existence of new growth of the affected organ, *e.g.* cysts of the ovary.¹ Adenomyomata are frequent; some 25 per cent of tubal adenomyomata are tuberculous.² (See “Adenomyoma and Tubercle,” Vol. II. p. 376.)

Pregnancy.—Marriage has been thought to be a predisposing factor, but it is more probable that marriage lights up an old lesion. Many cases certainly have symptoms just after labour or miscarriage, and there is some evidence that in the case of tuberculosis of the uterus, the lesion tends to be situated on the placental site.

Fertility.—Hardly one patient in twelve of those affected with this disease has been pregnant. This is due partly to the fact that such a large proportion of cases occur in patients who have not reached the age at which marriage is usual, and partly to the sterilizing effect of the disease itself when it affects the tubes or the endometrium. Many cases are, however, met with in which symptoms first show themselves immediately after labour or abortion.

Methods of Infection.—There are theoretically three paths—the ascending, the descending, and the blood (and lymph) stream—by which the pelvic organs may become infected with tubercle. A large amount of discussion has taken place as to which is the most important, but even now, in spite of experimental work, the question cannot be regarded as settled.

The Ascending Mucous Tract.—Excepting cases where infected tuberculous discharges from the bladder or bowel cause direct inoculation of the genital tract from below, the only practical method by which tubercle bacilli can be introduced into the vagina is by infected semen. The organisms have been demonstrated in the spermatic fluid of men with tuberculous epididymitis, and also in the fluid from phthisical men who have no local lesions clinically demonstrable.³ The next question is what is the fate of tubercle bacilli when thus introduced into the vagina.⁴ Here the results of experimental work vary; positive results have been obtained by several workers especially if the epithelium of the mucosa had been previously damaged. Gorovitz obtained positive results when the infected matter was introduced into the uterus of guinea-pigs, but not when merely placed in the vagina. Walker's results varied according to the technique employed; a local vaginal infection was obtained in a certain number of cases, but ascent of the

¹ G. Pampanini, *Ann. di Ostet. e Ginec.*, 1913, No. 7, p. 217.

² Rabinovitz, *American Journal of Obstetrics*, 1913, vol. lxviii. p. 711.

³ For summary of references see Gorovitz, *Revue de Chirurgie*, vol. xxiii. pp. 532 and 772.

⁴ See G. Walker, *Johns Hopkins Hospital Reports*, 1911, vol. xvi. p. 4.

infection to the uterus was found to be very rare. Especially in cases where abrasions of the vaginal mucosa exist, there is the possible fallacy that the organisms travel through the lymph-stream, although Bond ¹ has shown that foreign particles can travel upwards along the mucosa. Infection with the fingers, which have been moistened with infected saliva, is a possible means of local infection.

The clinical evidence is all against the ascending mucous path, and infection by spermatie fluid, as tuberculosis of the vagina, uterus, and tubes commonly occurs in virgins. It may be stated that such methods of infection, although undoubtedly possible, are in the highest degree exceptional.

Descending Infection.—In cases in which other abdominal lesions exist, such as tuberculous mesenteric glands or general peritonitis, it is easy for the organism to reach the fimbriated extremity of the tube by direct extension along the peritoneum, or by the ascitic fluid, and once the fimbriated extremity has been invaded the organism can spread downwards along the mucosa and affect the uterus, cervix, vagina, and vulva in succession; or it may pass over any one of these without infecting it, if the local resistance is high enough. It has been shown experimentally that foreign particles can pass from the peritoneal cavity to the vagina in animals. It has therefore been suggested, that bacilli ingested with the food may pass from the intestine and enter the peritoneal cavity without causing any gross lesion, till, owing to gravity, they reach the pelvis, and there, as a result of the local anatomical conditions, salpingitis may be set up. The frequency with which the most marked lesions occur near the fimbriated end of the tube supports this theory. In cases with tuberculous lesions of both the pelvic viscera and the general peritoneum, it is difficult to tell which is the primary focus, and which the secondary, unless one is obviously older than the other.

Infection through the Blood- or Lymph-Stream.—This method of infection can never be scientifically excluded in any case, and seems to be the only way of explaining cases of pelvic tuberculosis, where there is an isolated lesion in the genitalia, in a patient in whom no other tuberculous focus can be demonstrated, and in whom (subsequent to operation) no other focus develops, and whose cutaneous reaction to tuberculin, although positive before operation, subsequently becomes and continues to be negative. There are also clinical observations which strongly support infection by the circulation, for instance, where a single caseous focus is found in the centre of the uterine muscle. There is no reason why a local lowering of the resistance of the pelvic viscera in the female, should not make them specially susceptible to infection by an organism reaching them through the blood-stream, in the same way

¹ *British Medical Journal*, 1905, vol. ii. p. 233.

that the kidney or a joint may be affected in either sex. It should be noted that, according to Murphy,¹ tuberculosis of the mesenteric glands is rarely noted during operations for tuberculosis of the generative organs. Most authorities now regard the blood as the most important route of infection.

Co-existence of other Tuberculous Lesions in the Body.—As stated above there is no theoretical reason why primary lesions should not exist in the genital organs; but even with a post-mortem examination, it is difficult to prove that no older lesion exists in the body from whence the genitals were infected. Cases are found in the literature which seem to have been primary ones, but such cases must be regarded as exceptional, rather than as ordinary facts to be reckoned with, in formulating methods of treatment. In advanced cases other tuberculous foci are nearly always present, and in those which come to autopsy, Horizontow found phthisis in 90 per cent, peritonitis in 64 per cent, intestinal lesions in 56 per cent, and urinary tuberculosis in 42 per cent.²

Distribution.—The order of frequency in which the pelvic viscera are affected is—tubes, body of uterus, ovaries, cervix, vagina, and vulva. Several of these sites are commonly affected together in one patient. The percentage-frequency with which each organ has been found to be affected at autopsy, has been worked out by several observers. In round numbers the average figures are :

Tubes alone or in combination with other pelvic viscera 85 per cent.						
Uterus	„	„	„	„	53	„
Ovaries	„	„	„	„	15	„
Vagina	„	„	„	„	2.5	„

Prognosis.—The danger of this disease lies chiefly in the frequent coincidence of tuberculosis in other viscera—chiefly the lungs and intestinal tract, and death in most cases is due to asthenia, secondary to multiple tuberculous lesions. According to different observers, the urinary organs are affected in from 11 to 42 per cent of cases, and may contribute to a fatal result. Acute miliary tuberculosis occurs occasionally, especially after operative interference, or after labour and abortion. Tuberculous meningitis has been recorded as a terminal affection in more than one case. The formation of fistulae to the exterior or to the intestine, in cases of tuberculous salpingitis, is of prognostic importance, as they soon get secondarily infected and, once established, do not heal up.

In the absence of gross disease elsewhere, the points justifying a good prognosis are, the good general nutrition of the patient, the absence of fever, diarrhoea, and

¹ *American Journal of Obstetrics*, vol. xlviii. p. 737 and vol. xlix. p. 6.

² Horizontow, *Zentralbl. für Gynäkologie*, 1911, No. 52, p. 1731.

secondary infection. Sterility is usual in these cases, but pregnancy occasionally occurs in a quiescent case, and there the result is very unfavourable.

The course of the disease is usually slow, especially where the external genitalia are affected, but the prognosis, as a whole, must always be looked upon as serious.

TUBERCULOSIS OF THE VULVA

About one-quarter of all cases occur in children; in adults the commonest age is between thirty and forty. When it occurs in an adult it frequently comes on



FIG. 251.—Tuberculosis of the vulva; ulcerated type. (Xavier Bender.)
Showing lesions also involving the perineum and buttocks.

during or after pregnancy, or follows any trauma which destroys the continuity of the squamous epithelium of the vulva. It occasionally occurs as a primary lesion, but is usually secondary to phthisis or salpingitis. When secondary to lesions higher up the genital tract, there is little doubt that the discharge coming down from above is the source of the infection.

Varieties.—Two main types exist—the *ulcerated* (with or without hypertrophy), and the *non-ulcerated*.

The *ulcerated* is the commoner type (Fig. 251). The ulcers, which may affect either the labia majora or minora, are at first multiple with yellowish bases, and with, perhaps, greyish-purple granulations at the periphery. Later they coalesce, forming a larger ulcer with a serpiginous outline, in which healing may take place in one part while extension is occurring in another. The squamous epithelium at their edges is heaped up. The subepithelial tissues are infiltrated by round cells,

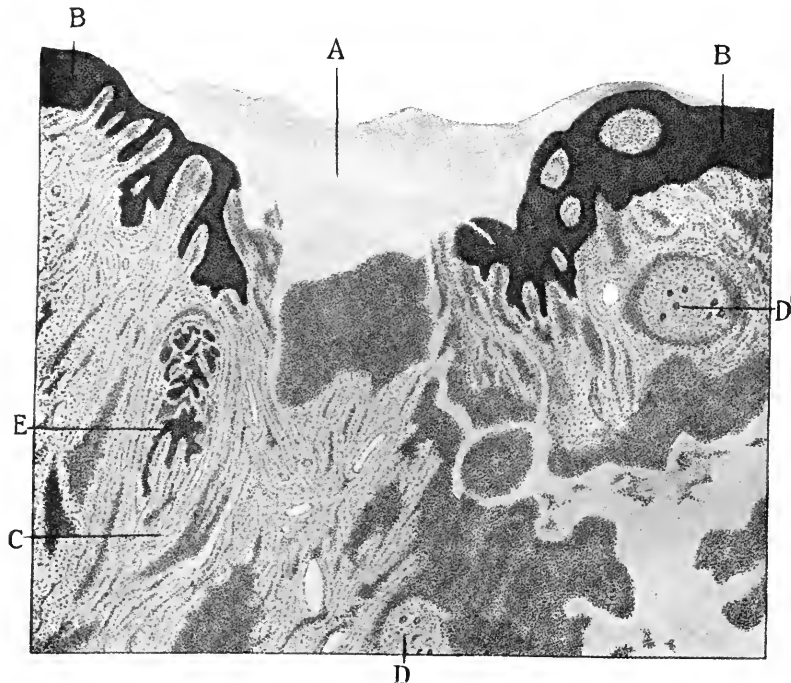


FIG. 252.—Section of a tuberculous ulcer of the vulva. (Xavier Bender.)

The surface of the ulcer (A) is covered by fibrin; beneath this is young connective tissue. The squamous epithelium (B) is thickened, the underlying connective tissue is oedematous (C) and infiltrated with leucocytes. Tubercles are seen at D and D'. E shows a process of epithelium cut obliquely.

and giant-cell systems are present (Fig. 252). The ulcers are frequently tender when touched.

There are often fistulous tracks leading into the paravaginal tissues, and the surface of the ulcer is irregular, from the presence of polypoid outgrowths of a purplish or a bluish colour. The connective tissue near the ulcer is oedematous. The inguinal glands are not affected until very late, as a rule. When much hypertrophy is present, dull-red infiltrated nodules form under the skin. These nodules soften and break down, forming ulcers which are mixed with polypoid overgrowths, so

that the whole labium is very much enlarged. Oedema and cracks are also present. The swelling may be so considerable that elephantiasis may be simulated.

The *non-ulcerated* type is rare; it has been fully described by Petit and Xavier Bender.¹ No ulcer is present, but the vulva undergoes irregular enlargement till it forms a mass resembling elephantiasis (Figs. 253 and 254). Both labia are as a rule affected. It occurs mostly in adults, and shows a strong tendency to recur after



FIG. 253.—Tuberculosis of the vulva; hypertrophic type. (Xavier Bender.)

operation. It is difficult to demonstrate the tuberculous nature of this affection, and a large number of sections may have to be cut before any proof can be obtained. Sections show oedema of the subepithelial tissues, and small-celled infiltration, especially round the vessels (Fig. 255). Giant cells and tubercles are scattered among the connective tissue, but are infrequent. Since the publication of the original cases, further examples have been described by Bender and others, and there is little doubt that such cases occur not very infrequently, but owing to the

¹ *Revue de Gynécologie*, 1903, No. 6, p. 947. Reference may also be made to a case described by Pöeverlein, Thesis, Munich, 1902.

extreme difficulty of proving their tuberculous nature they are rarely described as such.

Tuberculosis of Bartholin's gland is of the greatest rarity. Lecene¹ has described two cases.

Symptoms.—These consist of *pain*, especially during micturition, and occasionally pruritus. *Swelling* of the vulva may be the most noticeable symptom, especially in the hypertrophic form. *Discharge* may be complained of in the ulcerative form. In a case of Hartmann's² stenosis of the urethra was produced.



FIG. 254.—Tuberculosis of the vulva; non-ulcerated type. (Petit and Bender.)

Diagnosis.—A deep ulcer may bear a superficial resemblance to noma, but in the latter (which usually follows measles) there is gangrene with acute inflammatory induration around, and the child is very gravely ill with an acute disease. It has also been mistaken for diphtheritic vulvitis, but the long history, and the superficial ulceration with the presence of tuberculosis elsewhere, together with the absence of the typical greyish diphtheritic membrane, should lead to a correct diagnosis which can be confirmed by bacteriological means.

In adults the ulcerated form has been mistaken for soft sores, syphilis,

herpes, and epithelioma. When much hypertrophy is present there is a resemblance to lymphangioma and sarcoma. In the early stages, when the lesions are still characteristic, it should be easy to differentiate a tuberculous from a gummatous ulcer; but when secondary septic infection has occurred, and the whole vulva is distorted by oedema, granulations, and fistulae, it may be impossible to make a definite diagnosis, and some such cases have been thought to form a definite clinical entity to which the name *esthiomène* was given in 1849 by Huguier. It is in such

¹ *Annales de Gynécologie*, 1909, p. 77.

² *Bulletins et Mémoires de la Société de Chirurgie de Paris*, 1906, vol. xxxii. p. 956.

cases that the serological and bacteriological examinations are most valuable. The points of difference from an epithelioma are those mentioned under tuberculosis of the cervix (p. 604). Its differences from soft sores are that the latter are easily

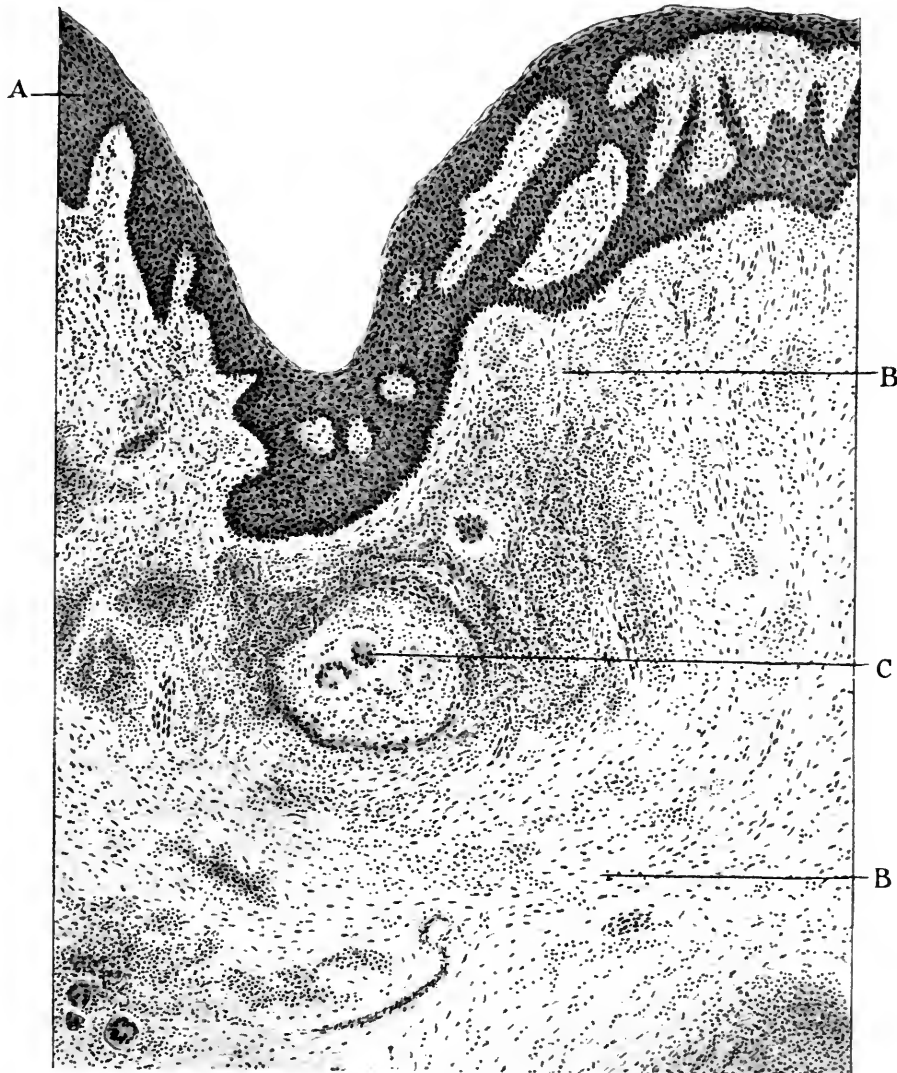


FIG. 255.—Microscopic section of part of *labium minus* from a case of non-ulcerated tuberculosis of the vulva. (Xavier Bender.)

A, intact vulval epithelium; B, oedematous connective tissue with small-cell infiltration; C, tubercles showing giant-cells.

inoculable on the thigh within forty-eight hours, their edges are excavated, sharp, and surrounded by a red area (whereas tuberculous ulcers are irregular and surrounded by a zone of livid tissue), they exude pus in large quantity, are present in

large numbers on both labia, and rapidly clear up in a few days under antiseptic treatment. The inguinal glands are usually enlarged and painful. Herpetic ulcers are unilateral, painful, and preceded by definite vesicles. Most other ulcers of the vulva are acute in onset and clear up rapidly under treatment. Syphilitic lesions tend to be chronic, but the condition of the inguinal glands and the presence of other secondary manifestations, together with a Wassermann reaction, should enable syphilitic lesions to be excluded.

The non-ulcerated form of Bender is semi-solid in consistence, but no definite tumour can be localized in the labium, thus differentiating it from a new growth. It resembles the semi-solid oedema which occurs in cases of chronic lymphangitis, but, on examination, no cause for chronic lymphangitis is present in the non-ulcerated forms. After amputation of the part, its tuberculous nature may be difficult to prove even with the aid of microscopic sections, as giant-cells are very infrequent.

Prognosis and Treatment.—In cases where the chief disease is in the pelvis, progress is slow, so that in adults cases may last many years, but in phthisical patients the prognosis is bad. In the non-ulcerated type progress is slow, and cases are on record of patients alive if not cured after seven to ten years,¹ but the great majority die of phthisis within a few years. In children the progress of the infection is rapid, and early dissemination occurs.

In the majority of cases the patient's general condition only permits palliative treatment such as painting the ulcers with 50 per cent solutions of zinc chloride or lactic acid, and irrigating the sinus, so that septic intoxication be prevented; or X-rays may be used. If an anaesthetic is permissible the whole vulva should be freely excised, or the ulcers should be excised or cauterised, and fistulae opened up and scraped. In the hypertrophic forms the masses should be excised and the edges united by sutures. The results of excision have been disappointing, and a local recurrence has occurred sooner or later in half the cases;² hence a wide removal must be effected.

As in all other tuberculous lesions of the generative organs the possible co-existence of carcinoma must be kept in mind.

TUBERCULOSIS OF THE VAGINA

The vagina is affected less frequently than the organs round it, because the absence of glands, and its lining of squamous epithelium, render it resistant.

¹ Merial, *Annales de Gynécologie*, 1907, p. 736; and Boursier, *Journal de Médecine de Bordeaux*, 1908, p. 693.

² Forgue and Massabau, *Revue de Chirurgie*, 1909, vol. xxxix, p. 1029.

Etiology.—The disease has been found at all ages but is most common during the child-bearing period. It comes on most frequently after parturition, when tears of the perineum and vaginal wall have opened up routes for infection. Similarly, previous infection by the gonococcus has been regarded as a means of lowering the resistance of the vaginal mucosa, and so favouring infection. It may also occur from tuberculous urine running into the vagina, or from the extension to the latter of fistulae originating in the bladder or rectum. The disease is rarely primary; clinically, it is usually seen accompanying tuberculosis of the cervix.

Varieties.—There are two forms—*miliary* and *ulcerative*: in the latter the ulcers tend to form in the posterior fornix, where discharges from the uterus collect, but they may also be found at the junction with the perineum or near the urinary meatus. The ulcer is, as a rule, elongated in the direction of the flow of the infected secretion. If extensive disease exists in the vagina, there may be oedema of the labia below. The ulcers are of the usual type, with sinuous outlines, showing where several smaller ulcers have united; they have yellowish bases and may be surrounded by purplish granulations. As the ulcers get deeper they tend to form fistulous tracks into the paravaginal tissues. In this way the walls of the rectum and bladder may be destroyed and incontinence of faeces and urine result.

Symptoms.—These consist of leucorrhoea (which may in advanced cases be streaked with blood) and of other symptoms depending on the leucorrhoea, such as dysuria, pruritus, and vulvitis. Local pain in the vagina is rare.

Diagnosis.—This must be made from other causes of vaginal ulceration, *e.g.* herpes, syphilis, soft sores, and carcinoma, all of which are rare in the vagina. It may also be mistaken for the septic ulcer which is often found in the posterior fornix as a result of wearing a pessary. These are single, are only found in contact with the pessary, and therefore correspond in shape to the area of pressure; they rapidly clear up under treatment, and any granulations round them are of the ordinary type and not the pale-purple granulations that accompany tuberculosis.

The so-called “strumous vaginitis” which occurs in debilitated children is usually septic or gonorrhoeal in origin, and is not due to tuberculosis.

Treatment.—This will depend on the state of the lungs and other pelvic viscera. In cases where the main lesion is in the vagina, the course of the disease is usually slow; but if untreated, the peritoneum becomes affected, and sooner or later fistulae form into the bladder and rectum. If the patient is too ill for radical treatment asepsis should be maintained by douches, and a mild caustic applied occasionally. X-rays or radium are also worth a trial, especially as any operative interference is attended by a grave risk of causing a recto-vaginal or vesico-vaginal fistula. If the

ulcer is high up on the vaginal wall, it may be removed by an extensive abdominal hysterectomy, as performed for cancer. Elsewhere, the ulcer must be excised with a margin of healthy tissue, and the edges united by sutures.

TUBERCULOSIS OF THE CERVIX

The cervix is affected in about 8 per cent of cases of tuberculosis of the generative organs; in the large majority of cases other organs are affected with it—chiefly the tubes and uterus, so that a descending infection is probable in these cases. An isolated lesion involving the cervix alone is rare.

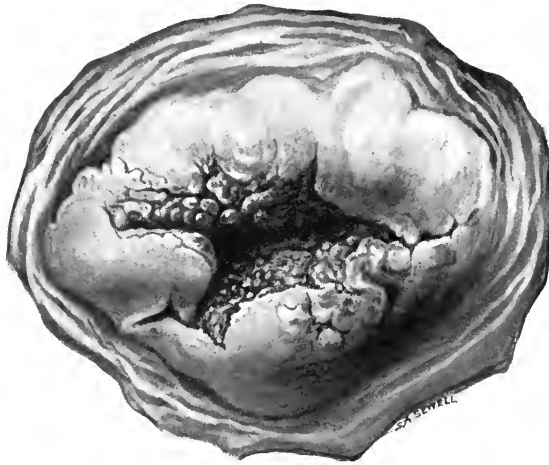


FIG. 256.—Tuberculosis of the *portio vaginalis*.

The *portio vaginalis* shows deep ulceration round the external os. The cervix is enlarged, especially the posterior lip. Papillary masses are to be seen at the edges of the cavity. The ulceration has not yet reached the vagina.

Etiology.—It occurs equally in multiparae and nulliparae. In the former it may come on after labour or abortion. It has been known to occur at all ages from puberty up to 79 years, but about half the cases occur in patients between 20 and 30 years of age.

Varieties.—The *miliary* form occurs associated with acute miliary tuberculosis of the whole body but is clinically unimportant. Clinically the *ulcerative* and *proliferating* forms may be recognized, and rarely, an *interstitial* variety has been described.

Their relative frequency is given by Chaton¹ as ulcerative 37, proliferating 22, miliary 7, ulcer and proliferating 6, ulcer and miliary 5.

Morbid Anatomy.—The *portio vaginalis* or the canal may be affected alone; of these the former is affected twice as often as the latter (eleven to six,² nineteen to six³), but in the majority of cases both are affected simultaneously.

In the *ulcerative* variety the ulcers are serpiginous in outline, sharp-edged, with whitish-yellow or greyish bases. They may be single or multiple and are situated near the external os. On section they resemble the ulcers found in the uterine body (Fig. 256).

¹ *Revue de Gynécologie*, 1908, p. 947.

² Polosson and Violet, *Revue de Gynécologie*, 1906, p. 205.

³ Beyca, *Reports of the Thirteenth International Congress of Medicine*, Paris, 1900, Gynaecological Section, p. 316.



Section from a tuberculous cervix. (Xavier Bender.)

The *proliferating* form may exist as fine papillary outgrowths causing the cervix to assume a dark-red fibrillary appearance (Fig. 257 and Plate XIV.). The oedematous, infiltrated glands here give the surface a velvety feeling. Less commonly there may be large sessile outgrowths, comparable in appearance with a cherry or a nipple. The whole surface of the cervix is dark red and frequently covered with mucus. Such outgrowths may block the cervix and cause a pyometra to form. On section, the glands are infiltrated with small cells and exudate, tubercles are found in the submucosa, and in the intermuscular and interglandular spaces. When these tubercles break down and coalesce, an ulcer with serpiginous edges must sooner or later result.

In the *interstitial* form the whole cervix is enlarged; tubercles are found in the muscle and connective tissue of the cervix, without mucosal infection.¹

There is a great tendency for glandular overgrowth to occur and, if the ulcer is on the portio, for the squamous epithelium to be thickened round it; hence, there is a resemblance to carcinoma, and in some cases carcinoma is also present.

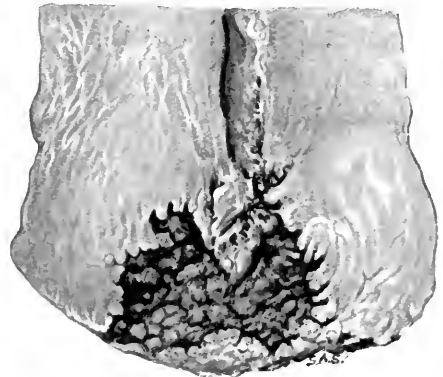


FIG. 257.—Tuberculosis of the cervix. Side view showing the *portio vaginalis* and a part of the canal.

Part of the cervix has been destroyed by ulceration; round this area small nodular and papillary outgrowths are seen. The upper part of the cervical canal shows no macroscopic change.

Symptoms and Physical Signs.—Except in the ulcerative form, the symptoms may be so slight that the disease is only thought of when the curettings obtained from scraping a supposed case of *cervicitis* are examined. In the usual ulcerative form the symptoms are those of *carcinoma*, for which it is usually mistaken. There is a leucorrhoea, which, if secondarily infected, may become offensive. It is tinged with blood, which increases as the ulcer gets deeper, or after a vaginal examination. Pain is usually very slight. The catamenia will depend on the condition of the body of the uterus; the possibility of the cervix being occluded by some lesion of its canal must be kept in mind. In primary cervical cases menstruation may be profuse from pelvic congestion. There is, as a rule, no fever, and the general condition of the patient remains good if the cervical lesion is the only one. The progress of the case is slow, especially in the papillary variety; in the ulcerative variety the progress is also slow, but fistulae tend to form.

On examination, the proliferating form looks like a bad papillary erosion. It

¹ See Chaton (*loc. cit.*); and also Petit Dutailis, *La Gynécologie*, Feb. 1913, p. 65.

is soft, friable, and very vascular, so that haemorrhage occurs when it is touched. There is no infiltration round it. The ulcerative form shows a serpiginous ulcer with yellowish-grey base, usually situated near the external os. It is slightly friable on pressure and therefore bleeding occurs on examination. The tissues round are not indurated and the discharge is usually simply pus. The tuberculous cervix has been described as "looking like carcinoma and feeling like cervicitis."

Diagnosis.—This has to be made from a simple erosion, and from the ulcers resulting from the bursting of cervical herpes (which are multiple, circular, and whose bases are red unless secondarily infected). From syphilitic ulcers and soft sores it is difficult to differentiate, and several cases have been treated by anti-syphilitic remedies, till failure has caused a microscopic examination to be made. The marked induration round a primary lesion, the undermined edges of a gumma, and the Wassermann reaction should give help.¹ But it is from the papillary and ulcerative forms of carcinoma that it is most difficult to make a differential diagnosis. The resemblance between the two conditions is so close, and they so frequently have been described as occurring simultaneously, that the final diagnosis will only be made in practice by the microscopic examination of a small piece of the tissue removed for that purpose.

Certain points may be mentioned as helping in the diagnosis. Carcinoma usually occurs in older patients than tubercle. In early carcinoma the discharge is typically blood-stained, whereas in tubercle it may be pure pus. A carcinoma is more friable and more indurated, and the tubes are rarely enlarged; whereas a tuberculous cervix is less friable and indurated, and tubal enlargement frequently coexists; also a longer history should be obtainable. If an apparently advanced carcinoma is still freely movable it should raise a suspicion that it may in reality be a case of tuberculosis. It will be seen from the above how closely the two resemble each other, how fallacious the differential points may be, and how necessary it is to remove a small piece in any suspected case for microscopic examination by a competent pathologist.

The **prognosis** in such a case is not very good, as it is so rarely the only tuberculous affection present, but patients in whom an isolated cervical lesion has been efficiently treated have usually done very well.

Treatment.—If severe pulmonary or other complications contra-indicate operative interference, the cervix should be cleansed of all mucus and then painted with lactic acid, 40 per cent formalin, or other caustic. The operative treatment consists in either removing the cervix by high amputation (preferably with the cautery) or

¹ See also Article on Syphilis (p. 674).—EDITORS.

removing the whole uterus. The former treatment gives excellent late results and is the operation of choice when there is no tubal enlargement. If it is thought that the tubes are also affected the treatment must be by hysterectomy. The abdominal route is to be preferred, on account of the adhesions which may be present, and which make a vaginal hysterectomy very difficult.

TUBERCULOSIS OF THE BODY OF THE UTERUS

Excepting the Fallopian tube, the uterus is the genital organ which is most frequently affected in women, as it is attacked in over 50 per cent of all cases. It has occurred at all ages, from infancy to after the climacteric. In young adults it is common, but is also found in children, as Still¹ found the uterus affected macroscopically in 8 out of 13 girls under 12 years of age in whom genital tuberculosis was found at autopsy. After the onset of puberty, the catamenia may be protective, in periodically removing some of the infected matter. It is generally secondary to tubal disease, but several cases are on record which appear to have been genuine instances of primary infection.

The cervix alone is involved in 2 per cent and the body of the uterus in 85 per cent of cases of uterine tuberculosis; in the remainder both are affected together. A high percentage of patients are multiparae, and many cases date back to parturition. Cases have been recorded in which gestation has taken place in a tuberculous uterus.

The commonest site for the disease is near the cornua, where it results from extension from the tube; but it may occur elsewhere, and during pregnancy has been proved especially to attack the place where the placenta is normally inserted (Fig. 258).²

Varieties.—Two types may be recognized, but all gradations between them occur; they are:

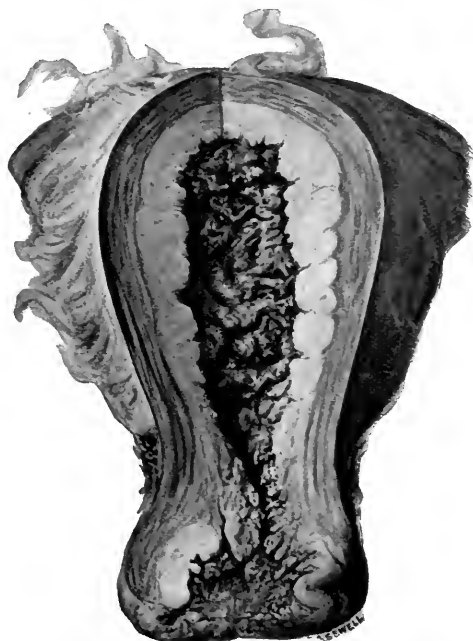


FIG. 258.—Tuberculosis of the uterus: tuberculous endometritis. (Natural size.)

The endometrium is greatly thickened so as to form polypoid masses inside the uterus. The disease is mainly above the internal os, but the cervix is slightly involved also. Adhesions are present on the peritoneal surface of the uterus.

¹ *Transactions of the Pathological Society of London*, 1901, p. 139.

² von Bardeleben, *Lancet*, June 29, 1912, p. 1751.

1. *Acute miliary type*.—This is of little importance, being met with in cases dying of acute miliary tuberculosis where every organ of the body is riddled with microscopic tubercles.

2. *The chronic type*.—This affects the endometrium in nearly all cases, and may be referred to as “tuberculous endometritis” although it should be remembered that the *submucosal* area is also affected. In the earlier stage the mucosa is macroscopically normal and then yellowish-white areas 1 to 2 millimetres in diameter become visible under the mucosa, especially near the fundus. Later, these ulcerate. The

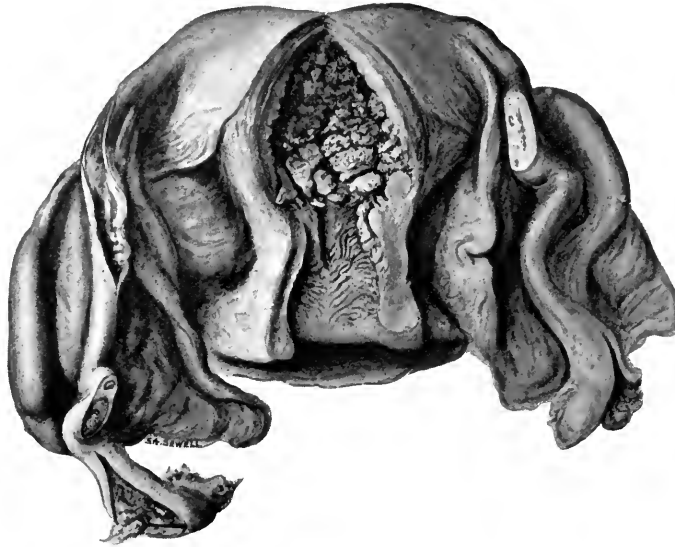


FIG. 259.—Tuberculosis of the uterus. (Natural size.)

(From a specimen in the Museum of St. Thomas' Hospital.)

The specimen shows the uterus of a child together with the Fallopian tubes and ovaries. The endometrium is thickened to form prominent papillary masses. The cervical canal shows no change, but both tubes are affected.

glands are also affected; they proliferate and project into the uterine cavity. The epithelium of the *lips* of the glands is shed, although that of the deeper portions of the glands remains, for a time, healthy. Tubercles may be found encroaching on the epithelium and also in the interglandular spaces.

Ulcers form as a result of necrosis of the epithelium and caseation of the tubercles. These ulcers are oval in shape, with yellowish-white irregular bases, and slightly indurated edges. On section, a layer of caseous matter and cellular *débris* is found on the surface, and then polynuclear cells and giant cells with small-celled infiltration below. If the cervix is blocked, the caseous material soon forms a pyometra. The internal os, however, forms no barrier to the extension of the disease, and in a late

case the cervix also becomes infected. A caseous abscess of the uterine wall is very rare, Mercade¹ in 1907 being only able to find 5 cases (of which one may be neglected) in the literature (Fig. 260).

The wall of the uterus is thickened in most cases, as considerable fibrosis is the rule; hence the uterus is enlarged. This is most marked where a pyometra is present. Occasionally the wall of the uterus is extensively thinned by ulceration as in a case recorded by Teyssier.² Tuberculosis may be found in a uterus which is the seat of a fibroid or a carcinoma, and in a clinic where tuberculosis is common this concurrence may be found in a surprisingly high proportion; thus Pampanini,³

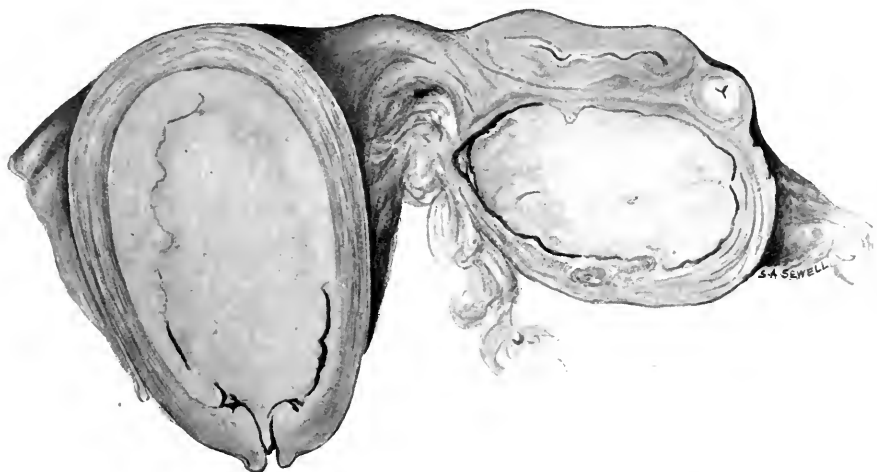


FIG. 260.—The uterus, tube, and ovary of a child showing tuberculous changes. (Twice natural size.)
(From a specimen in the Museum of University College Hospital Medical School.)

The cavity of the uterus is distended by caseous material to form a pyometra. The tuberculous foci in the ovary have coalesced to form one large caseous mass, which is surrounded by a shell of ovarian tissue. The tube is thickened. Numerous adhesions are present.

examining 150 tumours removed from patients with old phthisis, found pelvic tuberculosis co-existing with fibroids 3 times, ovarian cysts 9 times, and carcinoma once.

Symptoms.—These are not characteristic. *Menorrhagia* is sometimes noticed, which is later replaced by partial or complete amenorrhoea, due to destruction of the endometrium, the formation of a pyometra, or the general condition of the patient. *Leucorrhoea* is usually regarded as a prominent symptom, but in several typical cases it has been slight. If ulceration is present the discharge is muco-sanious in character, but where much caseation has taken place, the discharge consists of a muco-purulent fluid containing caseous *débris*. *Pain* is usually slight unless outside organs are involved, or a pyometra is present. In cases with amenorrhoea, pelvic

¹ *Ann. de Gynécologie*, 1907, p. 29.

² *Journal de Médecine de Bordeaux*, 1910, p. 806.

³ *Ann. di Ostet. e Ginec.*, 1913, No. 7, p. 217.

pain may occur at the time when the period should have come on. *Sterility* is naturally the rule.

Physical Signs.—The uterus is usually enlarged from fibrosis or caseation, and salpingitis is present.

Diagnosis and Treatment.—It may be said at once that, as there are no characteristic symptoms of tuberculous endometritis in the early stages, the diagnosis is made by finding giant-cell systems just below the epithelium when examining sections of curettings. If any suspicion of the nature of the disease exists, the discharges should be examined bacteriologically. In advanced cases caseous masses may be extruded from the uterus, and thus the nature of the disease be disclosed.

Uterine tuberculosis may be treated by curettage or by laparotomy. To decide between them it is necessary to consider whether the uterus is the only organ affected, and whether curettage is sufficient to remove the disease. The answer to the first point is difficult to give with certainty, as there are but few records as to the exact state of the appendages at the time that such cases are seen clinically. We know, however, from Simmonds' work,¹ that, at autopsy, although altogether the uterus was affected in 76 per cent of his cases, it was only in 11 per cent that it was the only organ affected. Hence in the large majority of cases, foci of pelvic tuberculosis would have been left behind after curettage. The second point is answered by a case recorded in detail by Vasmer,² in which a second curettage indicated the apparent success of treatment by curettage, but when a third was done it showed tubercle to be still present. Other disadvantages of treatment by curettage, are the difficulty of removing all the endometrium from the fundus, the grave risk of breaking down tubal adhesions during the necessary manipulations, and the possibility of perforating a uterus thinned by caseation. Finally curettage opens up routes of absorption and therefore, theoretically, favours the possible onset of acute miliary tuberculosis.

Inasmuch as, in the majority of cases of uterine tuberculosis, the tubes will be found to be palpably enlarged, and in a large proportion of the remainder will be microscopically infected, there can be little doubt that the proper treatment for such cases is to remove the tubes and also the uterus, by abdominal section.

TUBERCULOSIS OF THE OVARY

Although peri-oöphoritis is present in nearly all cases of tuberculous salpingitis, yet the actual substance of the ovary is only rarely affected. This is probably due

¹ *Arch. für Gyn.* lxxxviii. fasc. i. p. 29.

² *Arch. für Gyn.* Bd. lvii. p. 301.

to the germinal epithelium and the tunica albuginea resisting the entry of the organism.¹ When an opening occurs in these protective barriers, for instance, where a Graafian follicle has ruptured, the bacilli enter and infect the follicle or the corpus luteum. The presence of tubercle bacilli in the ova of the human ovary was demonstrated by Sitzenfrey in an ovary removed from a patient suffering from pulmonary and pelvic tuberculosis.² It is also possible for the infection to reach the hilum of the ovary through the lymphatics. Statistics from post-mortem records show that in cases sufficiently advanced to have reached a fatal issue, the substance of the ovary is affected in from 8 to 22 per cent of all cases in which tubercle attacks the generative tract. As a rule the disease is bilateral. It is always associated with disease of the tubes and peritoneum—as an isolated primary focus it is unknown (Fig. 261).

Two main stages in the disease may be recognized: in one the ovary is only slightly enlarged, and on section miliary tubercles are found in the cortex distributed among the connective tissue, Graafian follicles, and corpora lutea. The second type represents a later stage when caseation has taken place. The ovary is here enlarged up to three inches or so in diameter, and is filled with cheesy masses. In advanced cases it is merely

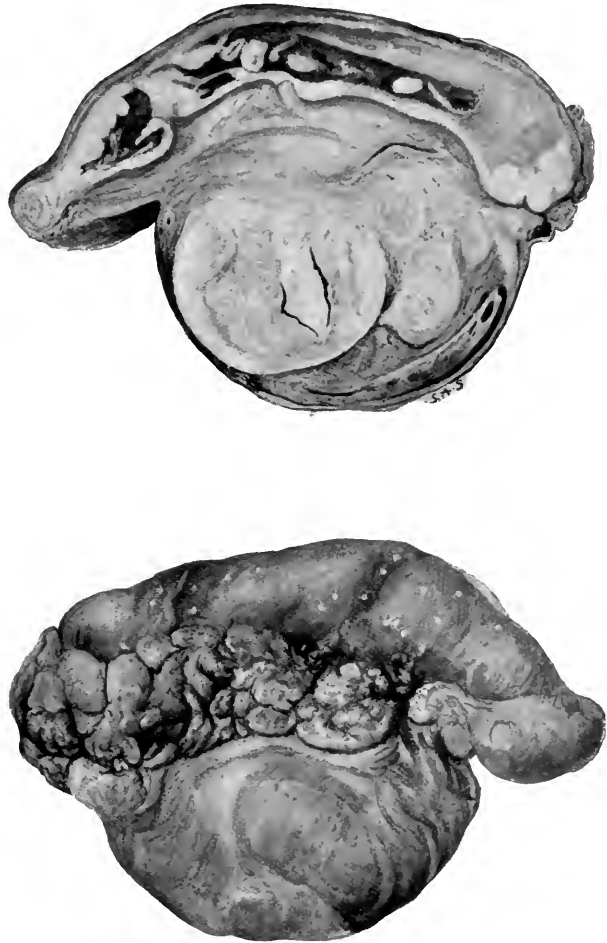


FIG. 261.—Caseating tuberculosis of the Fallopian tube and ovary. (Natural size.)

(From a specimen in the Museum of the Royal College of Surgeons.)

The lower picture shows the outside of the tube and ovary with tubercles on the peritoneum. Some of the fimbriae can still be seen on the surface. The upper figure shows the cut surface with caseous masses in both tube and ovary.

¹ F. Cohn, *Arch. für Gyn.*, 1912, vol. xevi. p. 497.

² A. Sitzenfrey, *Die Lehre von der kongenitalen Tuberkulose mit besonderer Berücksichtigung der Placentartuberkulose*. Berlin, 1909.



FIG. 262.—Tuberculous ovarian tumour.
(From a specimen in the Museum of University College Hospital Medical School.)

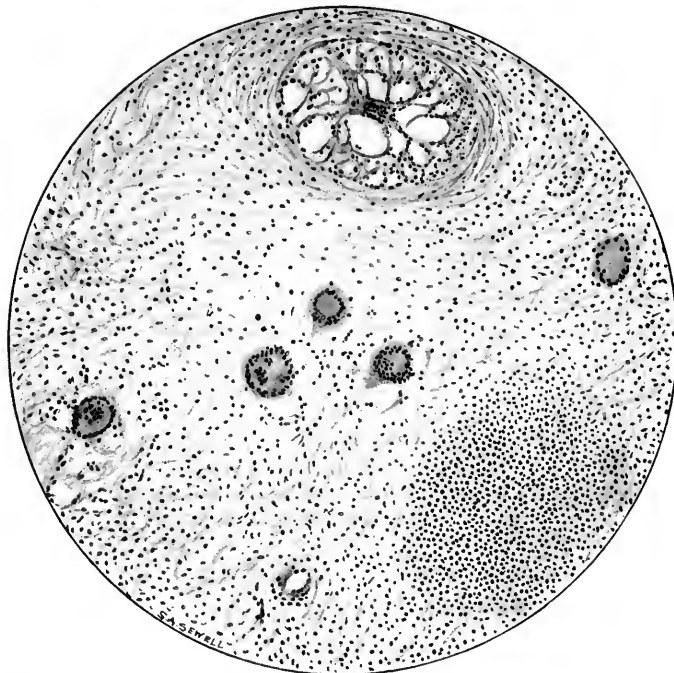


FIG. 263.—Microscopic section of wall of tuberculous ovarian tumour showing giant-cells.

represented by a shell containing a bag of pus. A mild infection may be followed by fibrosis instead of caseation. Tuberculosis of the parovarium is on record, and there are also many cases of tuberculosis of ovarian cystomata—in the majority the infection has been in the outer wall (Fig. 262).

The symptoms and physical signs will be those of tuberculous salpingitis and the treatment will be similar. Experience shows that the disease is nearly always bilateral, and that the tubes and uterus are also affected in a very large proportion of cases, hence the surgical treatment necessary to rid the patient of her disease will consist in excising the uterus with both appendages.

TUBERCULOSIS OF THE FALLOPIAN TUBES

Tuberculous salpingitis is present in at least 85 per cent of all cases of tuberculosis of the generative organs in women. This high proportion is to be explained by the horizontal position of the tube, its deep plications, and the smallness of its uterine aperture—all of which favour stagnation of any infected matter. The fimbriae, if patent, receive any infection descending from the peritoneum above. The peritoneum around the tube being affected in the majority of cases, it is difficult to state which of the two is primary and which is secondary. Different observers hold widely divergent views on this subject, some thinking that half the cases are primary in the tube, whilst others think that primary tuberculous salpingitis is a rarity (see Gorovitz, *loc. cit.*). Clinically, it is a fact that cases of tuberculosis of the general peritoneum, where the ascites re-forms after repeated simple laparotomy, are frequently cured by salpingectomy, thus suggesting strongly that the peritoneum is being secondarily re-infected from the tube (Mayo).¹ The existence of tubercles in greater number below than above the umbilicus, will suggest primary tubal disease with secondary peritonitis, whilst the converse will suggest primary peritonitis and secondary salpingitis.

Frequency.—Numerous careful observers have shown that with adequate investigation about 10 per cent of all tubes removed for inflammatory disease show old or recent tuberculous lesions.

Etiology.—An analysis of 253 cases showed that 15 examples occurred under 15 years of age, 109 between 15 and 25 years, 77 between 26 and 35 years, 38 between 36 and 45 years, and 14 after the 46th year. Sterility is usual but is not a cause; tuberculous salpingitis has been known to attack patients after 11 pregnancies. The puerperium is a time when the patient is especially prone to infection. Ectopic

¹ *Journal of the American Medical Association*, vol. xlv, No. 15, p. 1157.

gestation has occurred in tuberculous tubes. The co-existence of deficient development, infection, and new growth has already been referred to.

Pathological Anatomy.—As a rule the tubes are enlarged, especially in the ampullary portions (Fig. 264), and are curved on themselves (Fig. 269, p. 627). The walls are only slightly thickened, but nodules may be present near the isthmus.

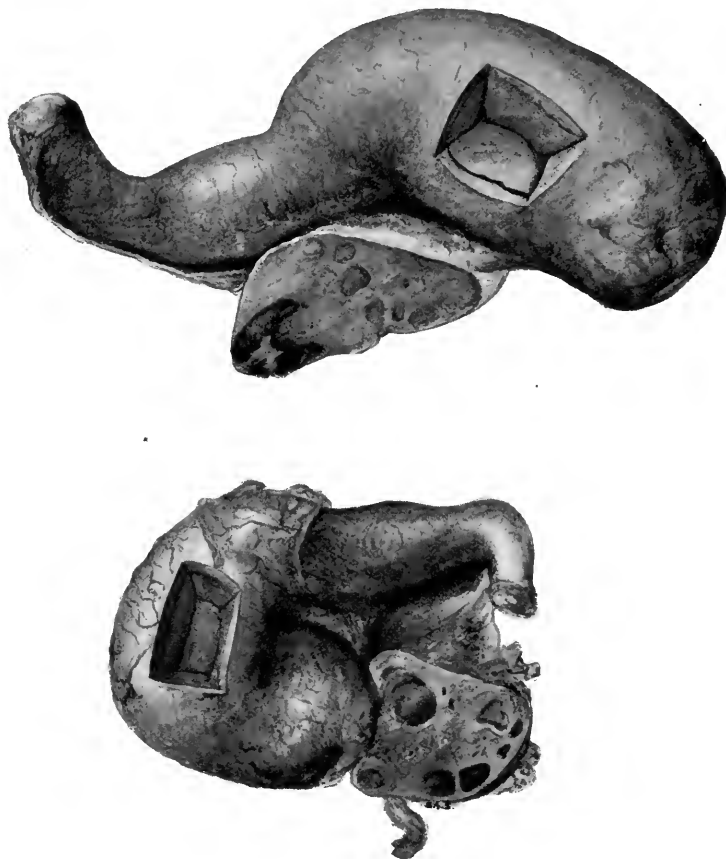


FIG. 264.—Bilateral tuberculous salpingitis; chronic stage. (Natural size.)

(From a specimen in the collection of Dr. Cuthbert Lockyer.)

The tubes are distended, especially in their ampullary portions. Pieces of the walls of the tubes have been removed to show their caseous contents.

Adhesions may or may not be marked. The fimbriae, even when the ostium is closed, are often not sucked in, so that they are still visible externally (Fig. 269).

Pathologically, three types may be recognized (*a*) perisalpingitis, (*b*) endosalpingitis, (*c*) interstitial salpingitis (Fig. 266) according to the part affected, although actually all three forms often occur together. In the first type, the peritoneum covering the tube is studded with tubercles. In the second, the mucosa is

swollen and infiltrated with small cells; the superficial epithelium of the tips of the papillary processes undergoes necrosis, and the papillae, thus bared, tend to adhere together at their tips and so form pseudo-cysts. There is a great tendency for the papillae to proliferate and invade the deeper layers of the tube, thus forming adenomyomata and even carcinomata, or the proliferated papillae may extend inwards and fill the cavity of the tube. Later the whole epithelium disappears and caseous matter lines the tube (Figs. 264 and 265). Calcification occurs in rare instances.



FIG. 265.—Tuberculosis of the Fallopian tubes and uterus. (Natural size.)

(From a specimen in the Museum of University College Hospital Medical School.)

The tube is split open along its whole length to show the endosalpingitis. The opposite tube was similarly affected and the endometrium showed slight thickening.

The interstitial variety shows giant-cell systems and in old cases, caseous foci in the wall of the tube. It is due to a blood infection.

In the early stages, the tubes themselves are only slightly enlarged, their fimbriae are only closed in about half the cases and but few adhesions are present. It is impossible to distinguish such tubes from ordinary cases of salpingitis except by careful microscopic examination. The most marked changes will be found near the fimbriated and uterine extremities of the tube. The ampulla is dilated to form a pyosalpinx of some size in one-third of all cases. They contain liquefied caseous material which, according to Targett,¹ is usually sterile. In cases which have been

¹ *British Medical Journal*, 1903, vol. ii. p. 959.

secondarily affected there may be true pus ; it is often green in colour and of unequal consistence as it contains fatty *débris*.

Occasionally the tube may be very much distended, so that it forms a big tumour, which may even extend above the umbilicus ; this is the so-called “ cold abscess of the tube.” For this to occur, it is essential that the tube-wall should be distensible

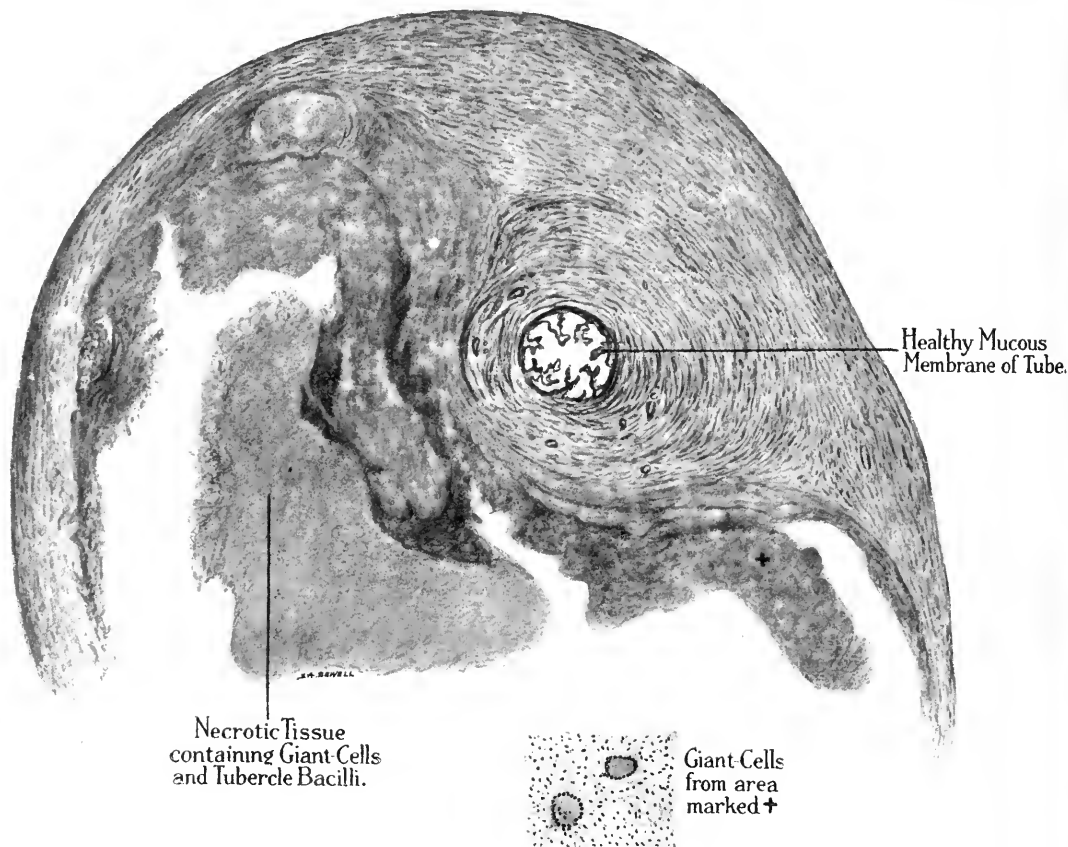


FIG. 266.—Interstitial tuberculous salpingitis.

Both the peritoneum and the mucous membrane are healthy, but a tuberculous nodule is present in the substance of the wall of the tube.

—that is, that it should not be fibrous or bound down by adhesions. Hence a cold abscess results from a mild infection of a previously healthy tube.¹

The walls of these cold-abscess tubes are greyish-white in colour, so that they somewhat resemble an ovarian cyst when first seen. The muscular layer is almost entirely lost by stretching, and all papillary folds disappear from the mucosa. Macroscopically there are very few signs of tuberculosis, and the peritoneum

¹ Salle and Forbaz, *Gazette des Hôpitaux*, 1912, p. 2017.

appears to be normal, but giant-cells may be found at intervals in the submucous layers.

Exceptionally a hydrosalpinx of tuberculous origin may be found.

In *advanced* cases adhesions are universal, and between them cavities are formed, containing free fluid or pus. These extra-tubal collections are particularly liable to secondary infection from the bowel. They may erode through to the skin, bowel, or even bladder¹ and form intractable fistulae. Peri-oöphoritis is usual, but the actual substance of the ovary is only attacked in 20 per cent of all cases (9 out of 47, Rives (*loc. cit.*)). Occasionally the mesenteric glands are found to be enlarged.

Clinical Features.—The symptoms which draw attention to the disease may be: (1) *Failure of the general health* with gradual loss of weight and appetite. (2) *Increasing size of the abdomen* due to ascites. (3) *Pain* in the iliac fossae and lumbar regions. The pain is usually of a dull aching character, with acute exacerbations, following trauma or exercise, and especially preceding menstruation. The acute exacerbations may also be due to perisalpingitis set up by the periodic discharge of tubal contents into the peritoneal cavity, which may take place when the fimbriae are not occluded. This aching pain resists ordinary methods of treatment and is only very slightly relieved by rest in bed. It is most marked in interstitial cases and those in which the adhesions are dense. (4) *Menstrual disturbances.* Dysmenorrhoea of a congestive type may be present, or attacks of pelvic pain may replace menstruation in cases of amenorrhoea. The latter is very frequently partial and more rarely complete. It is due rather to the general health and anaemia than to any local cause. On the other hand, menorrhagia occasionally occurs on account of the pelvic congestion. (5) *Leucorrhoea* may attract attention; if due to a co-existing tuberculous endometritis it may form a free purulent flow. Lastly, there are cases where *no symptoms* are caused, and where the existence of tubal disease is only found out at the autopsy of a patient dying from some other cause.

The mode of onset is usually insidious and the progress slow, so that the patient does not come for treatment until some months or years after the first onset. Occasionally the onset is subacute, and in rare instances acute.

Physical Signs.—On examination, there is often nothing to indicate the nature of the case. The abdomen may be enlarged if ascites is present; only rarely will the tube be palpable above the pelvic brim. On pelvic examination the uterus is normal and there are signs of salpingitis. The latter may not differ in any way from cases of tubal infection with other organisms, except that the tubal masses may be less

¹ Violet and Chalié, *Revue de Gyn.*, 1909, p. 41; also Israel, *Deut. med. Woch.*, Nov. 20, 1913, p. 2295.

tender. Small hard nodules may be palpable at the uterine end of the tube, and in the uterosacral fold; if present, these are characteristic.

Diagnosis.—In most cases this is made by finding giant-cell systems in the sections of tubes removed by operation. In some, the diagnosis is made at the time of operation, by noting tubercles on the surrounding peritoneum, or caseous masses in the tube.

The diagnosis is rarely made before operation, but an attempt may be made to do so by considering the history and physical signs together. If bilateral salpingitis is present in a virgin or in a patient in whom gonorrhoeal and puerperal sepsis can be excluded, and in whom there is no history of appendix trouble, or if there are signs of salpingitis without any history of an acute attack, it is very probably tuberculous. Again the presence of chronic salpingitis, in a patient with chronic phthisis, or salpingitis associated with chronic diarrhoea or ascites, should always be regarded with suspicion. The absence of metritis or any signs of gonorrhoea may be noted. If there is nocturnal pyrexia it will confirm the diagnosis, but many cases do not show this, and so its absence is not of much practical help. The general health is usually poor, and anaemia of a more or less marked degree is present; occasionally the disease is found in a patient of apparently robust health. It should be remembered that a burst papillomatous cyst or malignant peritonitis will give physical signs, which are very similar to those given by tuberculous tubes with adhesions in the pouch of Douglas and ascites. In such cases the organisms may be looked for in the discharges, although, as their demonstration is difficult, more help will be obtained from inoculation or from the tuberculin reactions.

Treatment.—In considering the question of treatment of cases in which a diagnosis has been made, perhaps more attention must be paid to the co-existing complications than to the tubal disease itself. If there is a tuberculous focus in the abdomen removable by surgical intervention, it is obviously to the patient's advantage to have it removed; but if the tuberculous tube is only a complication of advanced phthisis, the removal of the tube will not rid her of the whole, or even the greater part of her disease, and the operation may have a prejudicial effect on the phthisis; it has even been known to set up acute miliary tuberculosis. But in cases in which the pelvic lesion constitutes the main focus of the disease, it is usually best to operate. Operative treatment is certainly indicated in cases with free fluid, as these are known to be improved by simple laparotomy. The most difficult point to decide is whether the uterus and ovaries should be removed as well as the tubes. Considering that so many cases occur in young women, it is in the highest degree desirable to save them if possible. Unfortunately it is not surgically sound to leave the uterus—at

any rate in advanced cases—as Simmonds¹ found the uterus infected in 7 out of every 8 cases of tuberculous salpingitis, which he examined *post mortem*. Another advantage of removing the uterus is, that the uterine extremity of the tube is frequently the seat of a caseous nodule, so that it may be difficult to cover in the stump. The substance of the ovary is only found to be infected in about 20 per cent of cases, and therefore it is *comparatively* safe to leave it *in situ* provided the adhesions and peri-oöphoritis permit it. In removing the diseased tubes, it is important to deal with adhesions with the greatest care and gentleness, as otherwise the intestine may be torn and a faecal fistula formed. For the same reason, drainage tubes should be avoided whenever possible. No attempt should be made to drain a tuberculous abscess by the vagina as a chronic sinus results, and sooner or later infection spreads up it to the abscess cavity. Such drainage also makes the subsequent radical operation more difficult.

The after-results of surgical treatment are well given by Patel and Ollivier.² One hundred and sixteen cases in which tuberculosis was proved histologically, were followed up after operation; of these 17 were dead (9 as an immediate result of the operation and 8—mostly of tuberculous peritonitis—within two years of the operation). Nineteen were alive more than one year after, but could not be seen. The remaining 80 were seen at a period, which varied from a few months to eleven years after the operation; of these 80, 8 had been treated by simple laparotomy or by some vaginal operation, 17 by conservative abdominal operation, and 55 by abdominal operation, including hysterectomy.

After any operative treatment the patient should receive full general treatment in order to raise her resistance against further infection. If for any reason operative interference is contra-indicated, the patient should be placed under the best hygienic conditions possible in a sanatorium, in the hope of a natural cure resulting. Birnbaum and others report good results from the use of tuberculin.

TUBERCULOSIS OF THE GENERAL PERITONEUM

Evidence of either old or recent abdominal tuberculosis is found in 3 to 5 per cent of all cases at autopsy. Clinically, its frequency can be gauged from the fact that evidence of some form of tuberculosis was found in 184 out of 5687 patients on whom laparotomy was performed by the Brothers Mayo.³ It is rarely primary, as lesions—either healed or active—are usually found in the lungs or intestine.

¹ *Arch. für Gyn.* lxxxviii. fasc. i. p. 29.

² *Revue de Gyn.*, 1912, vol. ii. p. 147; and *Thèse de Lyon*, 1911–12.

³ *Journal of the American Medical Association*, vol. xlv. No. 15, p. 1157.

Etiology.—*Age.*—It is most commonly seen in early adult life, but also occurs frequently in children.

Fertility.—Thirty per cent are sterile, but many cases are on record of patients who have had children after being cured of undoubted attacks of tuberculous peritonitis. The puerperium is an especially common time for symptoms to arise; Kelly¹ found that 28 per cent of his cases dated from the puerperium. When acute, such cases have been mistaken for chronic puerperal sepsis.

Trauma and alcohol have been predisposing factors in some cases.

Infection.—Blood-infection occurs in acute miliary, and in other forms of tuberculosis, but the lymph-path from the intestine, appendix, mesenteric glands, and pleura is also an important route of infection. Ascending infection from the Fallopian tube may occur occasionally, especially when the tube is patent and the ostium not closed.

Varieties.—Excluding the acute form, which occurs as a terminal event in phthisis, or as part of acute miliary tuberculosis, and has little interest to the surgeon, there are three types of the disease: (1) the ascitic, (2) the caseous or ulcerative, (3) the fibro-adhesive. Their relative frequency in round numbers is 75, 5, and 25 per cent respectively.

The Ascitic Type.—In this variety the peritoneum is filled with fluid which is usually a clear, yellow, serous exudate, but is occasionally blood-stained or turbid, and may contain flakes of caseous lymph. The visceral and parietal peritoneum is vascular, and is covered with tubercles of varying size. The intestines may be distended with flatus, but if collapsed and thickly covered with membrane, they may form an adherent mass that has the appearance of a new growth more than that of intestine. The fluid may be encysted between adhesions instead of being free in the peritoneal cavity.

The Caseous Type.—This results from softening of the tubercles and so may follow the ascitic form. The caseous masses break down to form intraperitoneal abscesses which may become secondarily infected from the bowel. The mesenteric glands may be enlarged. Fistulae may result from perforation of the wall of the bowel; these are especially prone to point in the neighbourhood of the umbilicus. The capsule of the liver and spleen may be thickened.

The Adhesive Type.—This, as its name implies, is characterized by the formation of bands, binding the coils of intestine to the parietes, and to each other. There is usually some fluid present which forms encysted masses between the adhesions. The omentum and mesentery are retracted so as to form a mass in the upper part

¹ *Operative Gynaecology*, 1906, vol. ii. p. 237.

of the abdomen, and the intestines are drawn backward to the spinal column. Owing to the adhesions, the lumen of the gut may be narrowed, or strangulation may occur over a band.

The adhesive variety may be looked on as resulting from the resolution of the

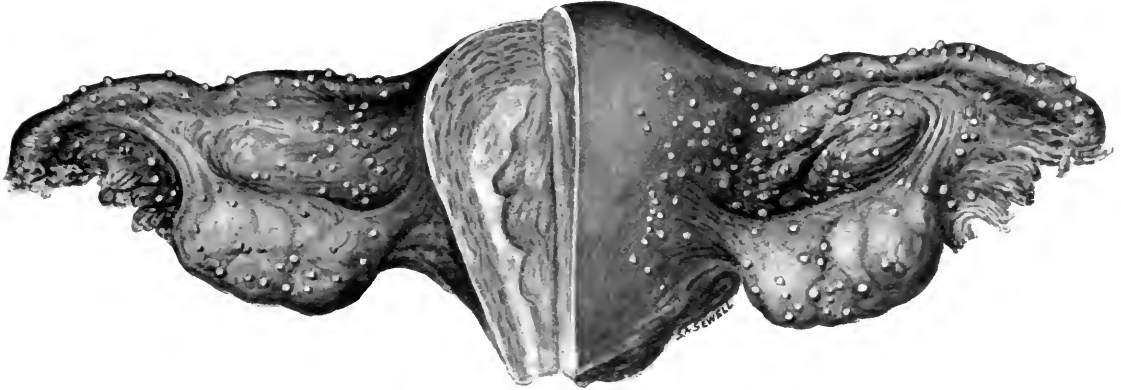


FIG. 267.—Early peritoneal tuberculosis.

The uterus, tubes, and ovaries, showing the condition met with in the early stages of tuberculosis. The surface of the tubes, uterus, and ovaries is studded with miliary tubercles, and the endometrium is also seriously affected. At the operation—performed mainly for the relief of ascites—the pelvic coils of intestine were found to be affected, but the upper abdomen was free from gross disease.

ascitic, and possibly of the caseous forms. Clinically, cases often show a combination of the above varieties.

Clinical Features.—After a prodromal period, characterized by abdominal discomfort and vague ill-health, the more definite *symptoms* of the disease appear. Pain in the abdomen increases, and intestinal disturbances such as constipation, alternating with attacks of diarrhoea, occur. The abdomen at the same time gradually increases in size; this is due to tympanites as much as the onset of ascites. The superficial abdominal veins become dilated. Vomiting is frequent and may be severe, but emaciation occurs even in the absence of vomiting. Dysuria is important, and menstrual irregularity may be noted. In some cases, pleural and peritoneal friction may be heard. In uncomplicated cases there is no leucocytosis.

In the *caseous form* the abdomen is less distended, but it is of irregular consistence on palpation, owing to the presence of masses formed of adherent gut, omentum, and glands; for a similar reason, the areas of resonance are irregularly mapped out. The region round the umbilicus may be indurated, but, as a whole, the abdomen feels tumid and doughy. The temperature is high and irregular, especially when secondary infection has occurred, but in uncomplicated cases it may remain normal.

In the *fibro-adhesive form* the abdomen may not be distended. The thickened

omentum may be palpable, and signs of partial intestinal obstruction may be present.

Diagnosis.—This is not easy; many acute cases have been treated as enteric fever at first, till the Widal reaction and the anomalous course of the disease have indicated the error. In arriving at a diagnosis of tuberculous peritonitis, the history and the presence of tuberculosis elsewhere, such as the lungs and Fallopian tubes, are of the greatest importance. On examination, there are usually signs of free fluid, and if the parietal peritoneum is thickened, the doughy feel of the abdominal wall is characteristic. The omentum, if contracted, forms a definite oblong mass in the upper abdomen—usually best felt on the left of the middle line.

The cases with free fluid resemble cirrhosis of the liver (which may exist at the same time). The resemblance to malignant peritonitis of ovarian origin is also extremely close, as in both there may be a soft mass in the pouch of Douglas, free fluid and irregular masses in the peritoneum. In such cases the tuberculin reactions may be helpful, but an exploratory incision, with removal of a small piece of peritoneum for microscopic examination, may be necessary before a diagnosis can be established. The inoculation of guinea-pigs with ascitic fluid obtained by aspiration is not absolutely reliable.

From a *lax ovarian cyst*, encysted tuberculous peritonitis may be differentiated by noticing the absence of dulness in the middle line, the absence of a definite cyst wall, the more irregular outline, the more rapid growth, raised temperature, and the possible presence of friction. If necessary, a bi-manual examination may be made under anaesthesia, with the cervix drawn down, so that the pedicle of an ovarian cyst, if present, can be felt.

The more acute cases resemble pneumococcal peritonitis; the encysted varieties have been mistaken for many abdominal conditions, such as hydronephrosis, sarcoma of the peritoneum, gastric and intestinal new growth, hydatids and appendicitis.

Prognosis.—This is best in the ascitic form, and worst in the caseous form where numerous purulent foci are present. It is better in the young than in the old, except in the case of young children, where the proportion of patients with miliary tuberculosis is high. The condition of the other viscera, especially of the lungs and intestines, is of the greatest importance. A grave prognosis is indicated in cases with a persistently high temperature denoting a mixed infection, diarrhoea with blood and mucus, persistent vomiting, marked emaciation, and the presence of fistulae. Regarding the remote prognosis there is always a chance of relapse, especially if the primary focus, *e.g.* Fallopian tube or appendix, is not removed, and in adhesive cases intestinal obstruction may result from strangulation over a band.

Treatment.—In general, if the case is diagnosed early, it is better to try the effect of sanatorium-treatment for six weeks, as some cases rapidly improve when so treated, and also because the results of laparotomy are not as good when performed during the first few weeks of the disease. Such treatment may be combined with tuberculin injections and X-rays.

In the adhesive and caseating types, the results of operative interference are not nearly as good as in the ascitic type, and therefore, in such cases, palliative treatment should be given a full trial, as little can be expected from surgery. In the cases with fluid, however, laparotomy should be performed, unless rapid improvement takes place under general treatment. The operation consists in opening the abdomen below the umbilicus: the abdominal wall is usually very vascular and the subperitoneal fat oedematous, and this, together with the fact that the peritoneum itself is altered in appearance, makes it difficult to see when the peritoneal cavity has been reached, and as the gut is frequently adherent, the greatest care must be taken not to injure it. The fluid is then evacuated, and the appendix and Fallopian tubes examined, and if diseased they should be removed. Mayo (*loc. cit.*) found that relapses are less frequent in cases treated by salpingectomy, than in cases treated by simple laparotomy, and that patients suffering from recurrence of ascites after as many as four laparotomies may be permanently cured by removal of the primary focus in the tube or appendix. The same operator stated that the results of an extensive operation involving removal of tubes, ovaries, and uterus were no better than those following simple salpingectomy, unless the uterus was also considerably affected.

The greatest care must be taken in separating adhesions, as intestinal fistulae very easily form and, once formed, never close. The abdominal incision should not be sewn up with through-and-through sutures for fear of a tuberculous sinus forming along the line of the suture. After operation the patient should continue sanatorium-treatment. Repeated evacuation of the fluid may be necessary before a cure is obtained.

The results of laparotomy are shown in the figures obtained by Wunderlich¹ who followed up a large number of cases for three years after operation, and found that the ascitic cases showed 23 per cent cures, the fibro-adhesive 9·8 per cent, while the caseous cases had no cures.

¹ *Archiv für Gynäkologie*, vol. lix. p. 216.

INFLAMMATORY AFFECTIONS OF THE FALLOPIAN TUBES

By Professor J. M. MUNRO-KERR
(Glasgow)

SALPINGITIS is the general term for all inflammatory affections of the Fallopian tubes, but as the ovaries are so generally involved in the inflammatory process the condition is often referred to as *salpingo-oöphoritis*. When the tubes become closed, and contain pent-up fluid the term *sactosalpinx* is frequently employed, and according as the contents consist of clear fluid, pus, or blood the condition is called *hydrosalpinx*, *pyosalpinx*, or *haematosalpinx*.

As *haematosalpinx* is an affection quite distinct from the others, and is often of a non-infective character and consequently not inflammatory, it is not considered in this chapter.

Etiology of Salpingitis.—Salpingitis is infective in origin. In the past the condition was sometimes attributed to constipation, a chill contracted during menstruation, mechanical interference with the circulation of the tube, etc. With a fuller understanding, however, all are agreed that infection, and infection alone, produces the lesions which have to be considered in this chapter.

In the majority of cases the infective organisms reach the tubes through the uterus, and the inflammation produced by them is an extension, by continuity of structure, of the inflammatory process in the uterus. Sometimes, however, the infection passes by the lymphatic- or blood-stream. Infection passing through the lymphatics and cellular tissue of the pelvis to the tubes is difficult to determine. In the cases which recover completely or which go to operation, and in which the tissues can be carefully examined afterwards, it is very difficult to say if the infection has entered the tube directly through the uterus or through the lymphatics and cellular tissue. Infection through the blood-stream is exemplified in cases of tuberculous salpingitis secondary to a lesion of a similar nature in the lungs, mesenteric glands, etc.

Further, salpingitis may be secondary, following a lesion of the intestinal tract. Naturally the most frequent lesion is appendicitis, but a ruptured gastric, duodenal, or epiploic ulcer may be the cause. When the infection arises from the appendix, the right ovary and tube are specially affected, and the tube, ovary, and appendix may be matted together and embedded in a small localized appendicular abscess. If, however, the appendicular abscess has been more extensive, both tubes and ovaries may be affected. Exactly similar, although very much less frequent, are those cases where the infection has followed a ruptured gastric or epiploic ulcer. In cases of this origin there is seldom anything of the nature of a pyosalpinx, although the abdominal end of the tube may be closed, and the tubes and ovaries may be matted together.

But although examples of salpingitis of odd and irregular origin are occasionally encountered, the disease in the great majority of cases results from an extension of a uterine infection, and the organisms pass from the uterus into the tubes. In many cases the infection occurs at the time of parturition, although it may follow the use of the uterine sound, curette, dilator, or any other instrument employed for intra-uterine medication. The infection occurs from the instruments employed, from the hands of the surgeon, but most generally from the imperfectly disinfected vulva and vagina of the patient. I lay stress on the latter mode of infection especially in connection with simple household, or outdoor-hospital, gynaecological work. It is generally recognized to be dangerous to pass either the sound or dilators unless the vulva and vaginal canal are properly disinfected beforehand.

Gonorrhoeal infection, which is responsible for fully 40 per cent of cases, is specially virulent if extension to the uterus occurs shortly after parturition, or immediately after a menstrual period. This is often very striking, and the reason of course is obvious, for *débris* and blood-clot abound on raw surfaces and present the best possible soil for the growth and the extension of the infective organisms.

When the infection is tubercular in origin matters are quite different, for the tube becomes infected through the blood-stream, as we have seen, or from neighbouring tubercular foci in the pelvic or abdominal cavity. It is very unusual to get a direct extension of tubercle to the tube from the vulva, vagina, or uterus, but the converse, *i.e.* extension from the tubes to the uterus, has been repeatedly demonstrated. (*Vide* Article on Tuberculosis, p. 593.)

In acute infections any of the ordinary pyogenic organisms may be found in 'pure' or 'mixed' cultures, but in very old-standing cases of pyosalpinx the fluid contained in the tube is frequently sterile. Andrews, for example, found in a series of 648 collected cases that the pus was sterile in 55 per cent. All other operators

have had a similar experience. This has an important practical bearing. In many cases the surgeon when removing chronic pus-sacs ruptures them and yet no general infection follows. But although that may often be the case every possible effort must be employed to prevent such an occurrence, for there is no guarantee that the pus is sterile. Particularly virulent is the pus met with in cases of puerperal infection. I have found active living bacteria in such cases two or three years after infection. It is therefore of the greatest importance that no pus should be spilled during the operation.

Pathological Anatomy of Salpingitis.—In the *acute* stage of infection the mucous membrane becomes swollen and congested, especially the fine plicae, and there is a serous and later a purulent secretion. There is also congestion and thickening of the fibro-muscular wall, so that the tubes become red, swollen, and oedematous in appearance. At this stage a muco-purulent discharge may sometimes be seen issuing from the fimbriated end of the tube.

If the inflammation does not speedily die down, but passes into the chronic state, the plicae adhere to one another and the tube itself becomes adherent to the ovary and surrounding structures—posterior layer of the broad ligament, uterus, intestines, and appendix. Should the tubes become closed, secretion gets pent up and they become distended. In such a condition they may present a retort-shaped appearance (Fig. 270), the ampulla becoming more and more swollen out as the secretion accumulates. If one examines the tubes in such cases the fimbriated ends are represented by a simple dimple owing to the fimbriae having become adherent and retracted. Whether the fimbriae actually retract, or the distended tube is pushed over the adherent fimbriae, is a question we need not consider here. The distended tubes may assume enormous dimensions but generally speaking they are of moderate size.

As the condition becomes *chronic*, the thickening of the fibro-muscular wall is found to vary greatly: in some cases it may measure several centimetres, and in others it is very thin. The wall itself consists largely of connective tissue, in the interstices of which are leucocytes in large numbers, and fibrin; the muscle-fibres are much destroyed. In section, the wall is seen to contain numerous pseudo-cysts produced by adhesions between plicae of the mucous membrane. These cysts often retain their lining of columnar epithelium, but the epithelium of the lumen of the tube is almost completely destroyed.

So far cases have been described which go on to the formation of sactosalpinx, but in many chronic cases of salpingitis distension does not form, or forms and disappears, and all that is left is a chronically thickened tube with the ostium sometimes

closed, or partly closed, matted to an infected cystic ovary, and more or less adherent to the uterus and broad ligament (Fig. 268). The lumen of such tubes may be almost entirely obliterated, or may contain a little caseous *débris*. Such are the cases generally referred to under the term *salpingo-oöphoritis*. In a sense the lesion is not so severe although it may be associated with an equal amount of abdominal discomfort and general ill-health. Women with such a condition, however, rarely have the very acute attacks to be described later.

As the inflammation, with the exception of cases of tubercular infection, generally spreads from the uterus, it is usual to find both tubes affected. Occasionally, how-



FIG. 268.—Salpingo-oöphoritis in an advanced stage.

The tubes are not much dilated; the left ovary is enlarged, cystic, and adherent.

ever, only one is found diseased, the other having escaped or having entirely recovered. But although both tubes are generally involved in the inflammation, one usually is more thickened or distended than the other.

In cases in which the salpingitis results from bowel infection, more especially from the appendix, the condition of the tubes and ovaries varies greatly. The right tube and ovary, and if the pelvic peritonitis has been widespread, the left also, may present the ordinary appearance of salpingo-oöphoritis and the abdominal ends of the tubes may be closed; but the damage to the tube is not so extensive, as a rule, as that which follows a salpingitis of the ordinary type. Pyosalpinx rarely follows an infection of this nature. This is a matter of great practical importance, for it may be possible in a case of salpingitis of appendicular origin to treat the ovaries and tubes in a much more conservative manner than is generally

possible in ordinary chronic salpingitis following uterine infection. Indeed, in many cases the removal of the appendix is sufficient.

Tubercular salpingitis may present all the appearances of an ordinary pyosalpinx, and the pus sacs may sometimes be of very large dimensions. But in the majority of cases there is no great distension of the tube. The special characters of tubercular salpingitis have been fully described on p. 611 and need not be here repeated (Fig. 269).

In cases of chronic salpingitis there occur at varying intervals acute attacks of pelvic inflammation, and it is a little difficult to explain these satisfactorily. They do not arise through a fresh infection of the vagina and uterus, and they certainly do not necessarily result from an escape of pus from the abdominal ends of the Fallopian



FIG. 269.—Tuberculous pyosalpinx.

tubes, for in most cases the tubal ends are closed; besides in old-standing cases the pus is very frequently sterile. The probability is that the inflammation results from a super-imposed infection from the bowel. In many of these chronic cases if operation is performed during an acute exacerbation, a procedure most unwise except in special circumstances, quantities of sero-purulent, and later purulent fluid is found around the tubes. In other words, the inflammation is *perisalpingitic*, and if abscesses form they are outside the tube. In such cases it is sometimes thought that the tube has ruptured, but that is a comparatively rare occurrence, and is attended by much more serious risk of general peritonitis.

Before leaving this brief review of the pathological anatomy of the subject I must refer to two other conditions, viz. hydrosalpinx and tubo-ovarian cyst.

Hydrosalpinx is now accepted as being infective in origin. Even streptococcal infection may be associated occasionally with serous effusion, as, for example, in some cases of pleurisy, especially in the course of puerperal infection. It is very

doubtful if hydrosalpinx ever results from simple congestion, and it is no argument in support of such a contention to refer to the frequency of this condition in cases of fibromyoma of the uterus, for pyosalpinx is also not an infrequent accompaniment of such tumours.

In hydrosalpinx the ostium of the tube is closed and replaced by a dimple. Here again the tube is retort-shaped, but the wall is very thin (Fig. 270). The ovaries in these cases are very frequently cystic. The uterine end of the tube is seldom sealed up, but owing to the congestion of the mucous membrane, or kinking of the wall, it is only rarely that the fluid in the sac is expelled freely into the

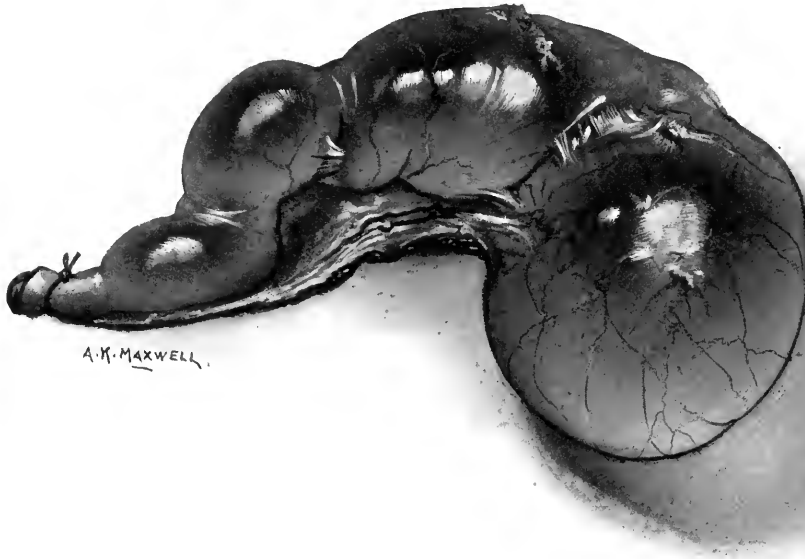


FIG. 270.—Hydrosalpinx.

uterus (*hydrops tubae profluens*). Occasionally the hydrosalpinx becomes freshly infected and a pyosalpinx develops, but it is difficult to understand how the converse change from pyosalpinx into hydrosalpinx can occur, although some authors of note believe it possible.

Occasionally a hydrosalpinx undergoes torsion. The symptoms of such a complication are precisely similar to those which occur in the more common conditions of torsion of an ovarian cyst (see Vol. II. p. 852).

Another condition related to hydrosalpinx is the *tubo-ovarian cyst*. This cyst arises from a communication being established between a hydrosalpinx and an ovarian cyst, and is of inflammatory origin. In some of the cases the distended tube, and in others the cystic ovary, forms the bulk of the tumour. Very

occasionally, the tube may communicate with a unilocular cyst of the broad ligament.

The symptomatology and the physical and clinical features of such tumours are the same as those present in salpingitis; consequently the condition will not be referred to again. Surgical treatment of the condition might be less radical than is generally followed. Usually the tube and ovary are removed, but seeing that the tubal lumen is often patent, it is possible in some cases to clip away the ovarian portion of the cystic swelling and leave the tube intact.

Acute Salpingitis

Clinical Features.—In actual practice tubes are seldom seen in a condition of acute inflammation. During a febrile puerperium, or in the acute stage of a gonorrhoeal infection, one may suspect that the inflammation has extended to the tubes, but as operative interference is seldom indicated, the gynaecologist rarely sees the condition until it has become thoroughly chronic. For example, although I have operated upon many hundred cases of salpingitis I have done so only three or four times in the acute stage. The two non-puerperal cases were so striking, and the results so disastrous, that it may be advisable to give them in detail.

CASE 1. Mrs. T., aged 32. The doctor in attendance was uncertain whether the case was one of acute salpingitis or appendicitis. The history of her illness was briefly as follows: On Thursday, although not feeling perfectly well, she was able to sing at a concert; on the following day she complained of severe abdominal pain situated more especially in the right iliac fossa. The temperature and pulse steadily increased, and on Saturday morning, when I saw her, the temperature was 101° and the pulse 130: the pain over the lower part of the abdomen was extreme, and the abdomen was particularly tender. I decided to open the abdomen. When this was done and the uterus pulled up, the red and swollen tubes were visible, and from their fimbriated ends drops of pus were issuing. The tubes were removed and the abdomen and pelvis carefully washed out. The patient, however, made no attempt at recovery, and died within twenty-four hours.

Cultures of the pus showed the infection to be a mixed one—both gonococci and staphylococci were present.

CASE 2. A few weeks later occurred the case of Mrs. A. I found her very prostrate, with a pulse of 140 small and thready in character and a temperature of 100.8° . Two days before she had been seized with acute abdominal pain more especially in the right iliac fossa. When I saw her the abdomen was much distended and tender, and she was evidently extremely ill. She was immediately removed to the Infirmary, and the abdomen was opened. When the uterus was pulled up and the tubes examined a

purulent secretion was found escaping from them. The tubes were removed and the abdomen cleansed and drained. The patient only survived a few hours. The infection here again was a mixed one of gonococci and staphylococci.

It is apparent from these two cases that acute salpingitis of non-puerperal origin may very closely resemble an attack of appendicitis, and indeed in certain cases it may be quite impossible to differentiate the two. The previous history in many cases is of assistance. Cases of acute salpingitis, apart from the puerperium, are usually of gonorrhoeal origin, and consequently there will generally be a history of a purulent vaginal discharge, and very frequently urethritis. In the two cases recorded, however, the infection seems to have been peculiarly virulent and to have spread to the tubes at a very early date, for there was no history of internal discomfort before the onset of the acute peritonitis.

Another feature which theoretically may be of assistance in the differential diagnosis is the situation of the rigidity. At an early stage in appendicitis the rigidity is localized, while in salpingitis, as both tubes are affected, rigidity may be found over the whole lower third of the abdomen. Too much importance, however, must not be attached to this, for the pain and rigidity are most varied in extent and distribution as the disease advances.

Treatment.—A. *Puerperal Cases.*—In cases of puerperal infection it is extremely difficult to tell when the tubes become involved. Consequently the local and general treatment consists in the first instance in employing the ordinary remedies for puerperal septicaemia; the uterus is douched, explored, and the finger used to remove any *débris* of placenta or membranes left behind, the diet is regulated, and such drugs as quinine, salol, etc., are given, according to the fancy of the medical attendant. Exploration of the uterus should be followed by the application of a 3 per cent solution of iodine, and an autogenous vaccine should be immediately prepared. I am absolutely convinced of the benefit of autogenous vaccines in this condition. I have had disappointments but I have had more successes. The real problem is when to interfere surgically, for without a doubt there are cases which can be saved by surgical interference and by nothing else. Unfortunately, however, one gets little help from the most careful clinical observations and the bacteriological report, as to when one should interfere surgically. Cases that look hopeless recover, and cases which at an early stage look fairly hopeful may die.

It is a very difficult problem, to formulate indications for surgical interference in this condition. But from my personal experience I think hysterectomy and salpingectomy should be performed in two groups of cases: (1) cases in which the patient shows evidence of a very early and severe infection; (2) cases which have

been going on for a week or two with a febrile temperature and all the other manifestations of infection, and are making no progress towards recovery in spite of the employment of an autogenous vaccine.

B. Gonorrhoeal Cases.—The routine treatment for gonorrhoeal infection of the uterus and tubes is absolute rest in bed, milk-diet, abdominal fomentations, and vaginal douches. Sedatives, such as morphia, must be given if the pain is extreme, but only if the physician is satisfied that the inflammatory affection is not of appendicular origin.

With acute salpingitis following a gonorrhoeal infection, surgical treatment is very rarely indicated, for in the vast majority of cases recovery, more or less complete, occurs without such treatment. But sometimes the woman dies, and I have just referred to two such cases. Death was not caused in these cases by the operation, although it followed the operation. These women were dying when they were operated upon. This, however, I will admit, that the treatment employed (removal of tubes) was futile, and now I would never employ such treatment. What should be done in these rare cases of acute gonorrhoeal infection where the woman is evidently going rapidly downhill to death? Hysterectomy might be and has been suggested, but it is too radical. I believe that the abdomen should be opened, for after all it is impossible in many cases to say whether the condition is a salpingitis or an appendicitis. Having opened the abdomen and found the condition to be acute salpingitis, no radical operation should be attempted. Counter-openings in vagina or loin should be made, and two large drainage tubes and gauze loosely packed round them should be inserted and brought out through the counter openings; the abdominal wound should then be closed, the patient put back to bed as quickly as possible and placed in Fowler's position.

Chronic Salpingitis

Clinical Features.—Chronic salpingitis presents as a rule fairly constant features. Generally speaking, the patients complain of pelvic discomfort amounting at times to more or less severe abdominal pain, premenstrual pain, dysmenorrhoea, menorrhagia, and leucorrhoea.

The abdominal uneasiness in some individuals is of old standing, and dates back to a febrile puerperium following a full-time labour or a miscarriage. In others where the infection is of gonorrhoeal origin a definite history of an acute gonorrhoea may be elicited. But in not a few of the latter group, especially cases infected from an old-standing gleet, the onset is so gradual and the acute stage so

slight in its manifestations that the condition may be described as chronic from the start. Very suspicious in this class are those who give a history of ill-health dating back to their marriage, especially if the general health and the menstrual functions were absolutely normal prior to marriage, for there are very few lesions except those of an infective nature which definitely follow marriage.

Recurrent attacks of abdominal pain, another striking feature, are very variable in their severity and frequency. The cause of these attacks is variable. In some individuals the attacks seem to follow exposure to cold, over-exertion, fatigue, or constipation, but on many occasions they occur apparently for no particular reason, and certainly the interval between the attacks is very variable. So also is their severity, for all degrees may be encountered, from attacks which seemingly give rise only to a little abdominal pain, to others attended with such severe pain that fomentations and sedatives are the only remedies which give relief. The pain during these acute attacks is generally referred to the lower abdomen, but very frequently it is more pronounced upon one or other side, and usually the same side with each attack. Associated with the pain there is rigidity, sometimes general, but usually more marked over the painful side.

Another symptom of chronic salpingitis is *premenstrual pain*. Very frequently for a day or two before the onset of menstruation the pelvic discomfort is increased. With the menstrual discharge, however, comes relief, the escape of blood relieves the congested organs, so that the subjects of chronic salpingitis state that they feel at their best during menstruation, and for a week following its termination. The menstrual discharge is usually decidedly increased, and the duration of the periods is longer. The coexisting metritis and endometritis explain this menorrhagia. They also explain the leucorrhoeal discharge which is almost invariably present during the menstrual intervals. Other local disturbances are common. Constipation is very general, and irritability of the bladder is often complained of. The bladder disturbances are sometimes due to pressure, but more frequently they are evidences of mild attacks of cystitis.

In addition to the local discomforts mentioned, the subjects of salpingitis invariably suffer in their *general health*. They seldom feel quite well. For a few days or even occasionally for a week or two, they may enjoy almost perfect health; but headache, backache, digestive discomforts render life uncomfortable, and very generally these and the local discomforts described compel them to seek medical advice, and in the end force them to give the gynaccological surgeon a free hand to do whatever he deems best for the relief of their suffering.

But if the history of the patients who suffer from chronic salpingitis is often

indefinite, the physical signs are characteristic. On making a bi-manual examination (and the examination to be satisfactory must in many cases be made under an anaesthetic), the fixation of the uterus is the most important feature. In many cases the fundus is difficult to define because of its being retroverted. This is not always so, however, for with large sacs behind the uterus the organ may be pushed forward. It is impossible to emphasize too strongly the importance of fixation of the uterus; very rarely indeed does one find this condition apart from malignant growths or an infective disease of the uterine adnexa. In addition to the fixation of the uterus there will be discovered swellings behind and to the side of the uterus; these are the inflamed tubes and ovaries matted together in adhesions. Very generally these tumours are tender to the touch, but in very chronic cases and during the quiescent stage they are sometimes surprisingly insensitive. In many cases the condition of the tubes can be best defined by a bi-manual rectal examination.

The size of these swellings is variable, and the two are seldom equal. When the tubes are sealed up and sclerosed they are felt as small irregular swellings closely adherent to the fixed and backward-displaced uterus. Should they contain pus, however, they may assume large dimensions, *e.g.* they may be as large as the foetal head. One is much larger than the other as a rule, and so the larger often masks the smaller. They are very rarely found in front of the uterus. But although after removal they may present the typical retort shape, *in situ*, owing to the matting to the uterus, and the surrounding parts, they are often only distinguishable as irregular tender fixed swellings.

Diagnosis.—The diagnosis of this condition of chronic salpingitis is seldom difficult, but occasionally retro-displacement of the uterus, small ovarian tumours, especially dermoid tumours, cellulitis, myomata of the uterus, extra-uterine pregnancy, and appendicitis very closely simulate it.

Simple retroflexion of the uterus, in which that organ is enlarged and tender, presents features very similar to chronic salpingitis. It is, however, smoother in outline, and there are no fixed swellings to the side of the pelvis as is the case with salpingitis. If the uterus is fixed the condition closely resembles salpingitis, but as explained, fixation of the uterus, apart from salpingo-oöphoritis, is very rare indeed. The differential diagnosis is therefore made by replacing the organ manually or by the uterine sound. To do this if the uterus is tender it is often necessary to anaesthetize the patient. If it comes up easily, the normal ovaries and an absence of any tubal swellings can usually be discovered.

An ovarian tumour only simulates a salpingitis when the tumour is firmly fixed in the pouch of Douglas; a movable ovarian tumour is easily differentiated from a

salpingitis for it can be defined as quite distinct from the uterus. An important distinguishing feature is that in salpingitis the tumours are usually double, whilst in ovarian tumours the swelling is usually single. But it is not very uncommon to encounter tumours of both ovaries. Generally speaking, ovarian swellings are less tender, more movable, more often unilateral, and are associated with less general and local disturbance than inflammatory affections of the tubes.

Chronic Cellulitis.—In chronic cellulitis, as the whole of the pelvic contents are affected, it is generally found impossible to define exactly the condition of the tube; as a matter of fact the two conditions often coexist.

Fibromyoma.—An uncomplicated fibromyoma of the uterus does not simulate salpingitis. But fibromyomata burrowing into the cellular tissue, and especially fibromyomata complicated by cystic degeneration of the ovaries and salpingitis (combinations that are by no means uncommon), are occasionally very difficult to differentiate from ordinary salpingitis.

Extra-uterine Pregnancy.—Another condition which may occasionally simulate or be simulated by salpingitis is extra-uterine pregnancy. Generally speaking, the history of the case, and the unilateral tender swelling behind and to the side of the uterus, make the diagnosis of ectopic pregnancy fairly simple. In a few cases, however, especially where the ectopic sac has been in existence for some weeks and a certain amount of blood has escaped from the abdominal ostium or a small rupture of the sac-wall, the physical signs of the two conditions are very similar, for in both the uterus is fixed and an irregular swelling is felt behind it. If, however, the history is gone into very carefully a correct diagnosis can be made in most cases.

Appendicitis.—But while these various conditions occasionally simulate or are simulated by salpingitis, the one which most closely resembles salpingitis is pelvic inflammation associated with appendicitis. It is often impossible to decide before operation whether the case is one of salpingitis or appendicitis. Fortunately both conditions require the same radical treatment.

We have already seen that in a number of cases of chronic salpingo-oöphoritis the patients suffer very little disturbance or discomfort; naturally, in such, no treatment is necessary. In the majority of cases, however, the discomforts are so great that sooner or later the subjects of this affection are compelled to seek medical advice.

Palliative Treatment.—In the first instance palliative measures should be tried, but as the condition is chronic it will rarely be found that much good results from such treatment. The routine palliative treatment of salpingitis is rest, hot douches and vaginal tampons of glycerine, or glycerine and ichthyol (8 per cent). Very generally such treatment lessens the patient's discomforts for a time. Additional relief

may be secured sometimes by the application of blisters or antiphlogistin over the abdomen, and an electric-light bath applied under a cage over the lower abdomen. In some cases temporary relief may follow the employment of X-rays, and some cases are benefited by a course of treatment at certain Spas. Very frequently the general practitioner employs a pessary with the object of keeping up the displaced uterus, but, speaking generally, a pessary only aggravates the condition, for the uterus is fixed and cannot be kept in a normal position by such means. I have tried, but I cannot say with any success, both "stock" and "auto"-vaccines.

The only drugs I have seen do any good are simple general tonics, such as strychnine, arsenic, and iron. As regards the last mentioned I believe the syrup of iodide of iron is the best. But in my experience few of the palliative measures mentioned are of any permanent benefit, and are absolutely useless in pyosalpinx or hydrosalpinx.

Operative Treatment.—Before considering details regarding the operative treatment of salpingitis there is one important matter which must be referred to, and that is, the best time to operate. In many cases of salpingitis, more especially the cases of salpingo-oöphoritis in which the tubes are sclerosed, it is of no consequence; any time in an intermenstrual period may be chosen. But in cases of pyosalpinx in which acute exacerbations occur it is of great importance to delay operation until everything—pulse, temperature, pain, etc.—has become quiet. An operation performed during the acute stage in this class of case is attended with a mortality three or four times higher than in the quiescent stage. Salpingitis is very different from appendicitis. The latter condition must be operated upon immediately for there is danger of general peritonitis. But with the former there is little danger of this. The pus-sacs are surrounded and supported by old inflammatory adhesions, and it is a rare thing for a pyosalpinx to rupture and produce a general infection of the peritoneum.

If it becomes necessary to operate during an acute attack, the operator should seriously consider the advisability of opening into the pelvic cavity through the posterior vaginal vault, not with the idea of removing the pus-sac but simply with the object of draining more particularly the perisalpingitic effusion which so often develops during the acute stage. In other words, he treats the condition as a general surgeon does an appendical abscess when the appendix cannot be reached, or when its removal would involve too much handling and delay. The radical operation can be performed later when everything has become quiet.

The operative treatment of salpingitis is still a subject regarding which much difference of opinion exists. The majority of operators, however, seem fairly well

agreed upon two points: (1) that conservative surgery in chronic infective disease of the tubes and ovaries is disappointing; (2) that if both tubes and ovaries are so diseased that they must be removed, then the uterus also should be extirpated.

(a) *Conservative Methods*.—Naturally these methods of treatment can only be considered when there is no pus-accumulation in the tubes, and when tubes and ovaries are moderately healthy. It is generally agreed that the resection of inflamed tubes very seldom indeed gives satisfactory results. In former years I frequently performed such operations, but in only one case so far as I know did a pregnancy follow; while in several cases the more radical operation was required later on. I

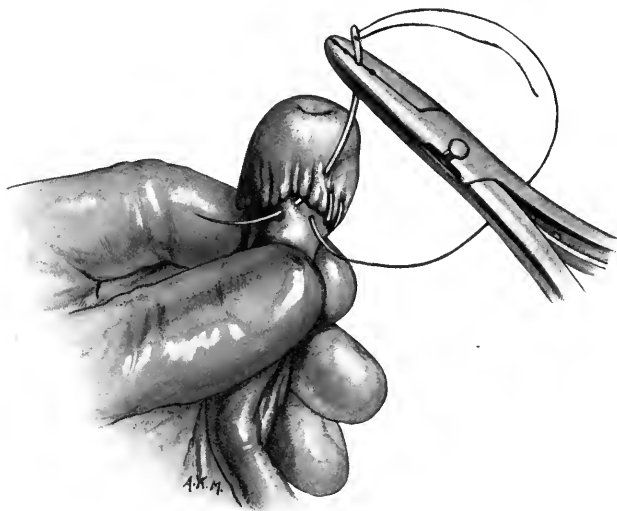


FIG. 271.—Salpingostomy.

have therefore given up attempting to save the tube except in certain cases of hydrosalpinx, tubo-ovarian cyst, and haematosalpinx, or in those rare cases where one tube has almost escaped, or almost completely recovered from the inflammatory attack. On the other hand it is always advisable to leave an ovary or a portion of an ovary if the organ is sufficiently healthy and the patient is under forty years of age.

The operation for reopening a sealed tube is called *salpingostomy* (Fig. 271) and is carried out as follows: The tube is split open at the fimbriated end to the extent of 2 inches and the ends turned back and stitched to the peritoneal aspect of the tube wall. Sometimes all the fimbriae of the tube are not invaginated, and there is still a small opening into the tube. In such cases fine pressure forceps may be passed and the abdominal ostium dilated when the invaginated fimbriae appear, and a fairly healthy and normal fimbriated extremity may be made. This also applies in many cases to the tubo-ovarian cyst, for when the cyst is opened a satisfactory fimbriated end can be secured by clipping away the cyst wall.

In some cases of salpingo-oöphoritis when the tubes are sclerosed they may be shelled out from the upper border of the broad ligament leaving the ovaries untouched. Figure 272 indicates the manner of carrying out this procedure. An incision is made parallel to and just below the tube on either the posterior or anterior aspect of

the broad ligament. The tube is enucleated from its bed. The uterine end of the tube and the upper border of the broad ligament are then stitched over with a continuous catgut suture. If the ovaries are adherent, as they generally are, to the

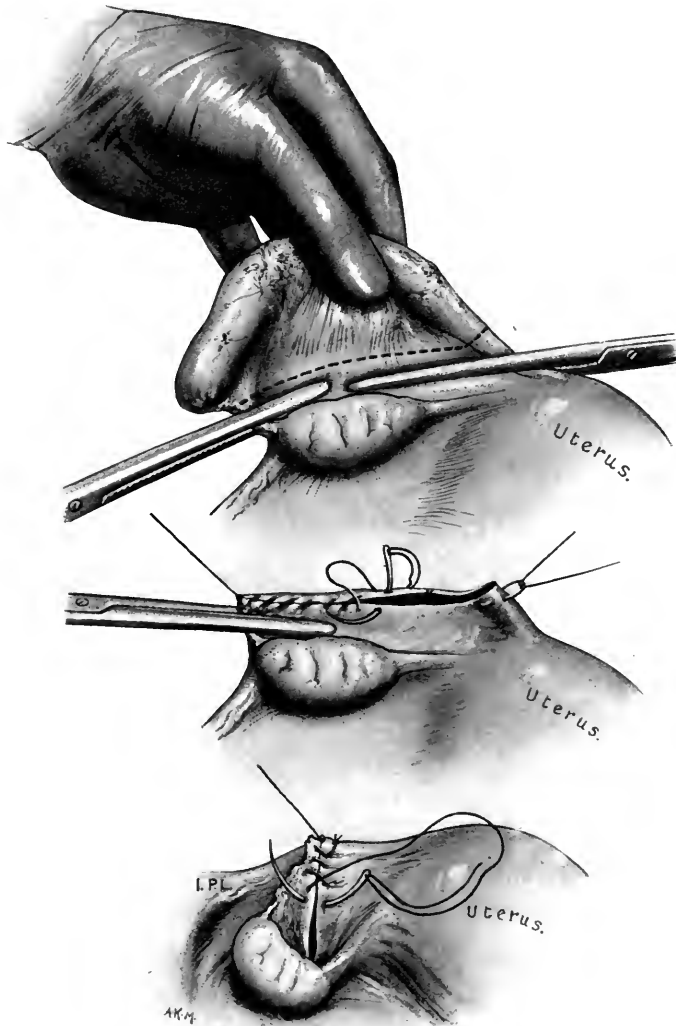


FIG. 272.—Tubes enucleated from the broad ligament, and raw surface stitched over.

posterior surface of the broad ligament, they are freed and attached in a more favourable position. The operation, however, is often disappointing for the pelvic pain, uneasiness, and menorrhagia are kept up by the chronically inflamed ovaries left behind.

(b) *Radical Operations.*—As already stated a considerable number of gynaeco-

logical surgeons are in favour of removing the uterus as well as the tubes when radical surgical measures are necessary. The arguments used by those who favour the alternative method of leaving the uterus behind also deserve consideration.

Those who advocate hysterectomy in addition to salpingectomy claim (1) that a uterus without tubes and ovaries is a useless organ, for pregnancy cannot occur and it has no internal secretion; (2) that the uterus left behind is a source of danger to the patient because it is infected and chronically inflamed; (3) that the operation is much more cleanly; and (4) that the pelvic floor is much more satisfactory than if the uterus is left behind. Those, on the other hand, who advocate the less radical operation and leave the uterus behind, claim that the operation is simpler and consequently has a lower mortality, and that the patient has a less severe menopause.

The only point which is worth discussing is the relative severity of the menopause after the two methods of treatment. To say that salpingectomy is easier and safer than salpingectomy *plus* hysterectomy is incorrect. In my experience the mortality is much lower after the radical operation, and I think it is only natural that it should be so. When one removes the whole mass—uterus, tubes, and ovaries—*en bloc*, there is less pus spilled, the field of operation is kept cleaner, and there are no septic stumps of tubes and no chronically inflamed uterus left behind.

The question of the severity of the menopause in the two operations is, however, important. This matter is being very much discussed at present, and there are some who maintain that the menopause is much worse if the uterus is removed. This is open to question, and certainly my own experience does not support such a contention. Presumably the uterus has no internal secretion, although it certainly is an excretory organ during menstruation. But when the tubes and ovaries are removed, menstruation ceases except in those cases where a small piece of ovarian tissue is left behind. It is just in the exceptional cases where menstruation continues that the uterus gives most trouble. Menstruation is often excessive and the discomforts are so great that not infrequently a second operation has to be performed and the uterus removed. I am of opinion, therefore, that the uterus should be removed whenever both tubes and ovaries have to be sacrificed. By all means leave an ovary or small piece of ovary if that is possible, but if that is impossible do not hesitate to remove tubes, ovaries, and uterus. With few exceptions the results of this operation are most successful.

Removal of Tubes (Salpingectomy).—When this method is employed the distended tubes are separated from the surrounding tissues to which they are adherent. In many cases the adhesions to the different structures are very intimate and especially difficult to break down (Fig. 273). Particularly dangerous is the separating of the

tubes from bowel, for any rough handling of such adhesions is liable to result in tearing of the bowel-wall. The best way to separate such adhesions is to sponge them with swabs wrung out of warm saline solution.

This plan always succeeds when the adhesions are comparatively loose. But when they are very intimate it is not so easy, and tearing of the bowel readily results. Careful snipping with probe-pointed scissors, the point of the scissors being kept



FIG. 273.—Separating a pyosalpinx from adhesions.

against the tube-wall, will often prove successful, and when the line of separation is defined, pushing the closed scissors between the distended tube and bowel and opening the blades may prove helpful.

It is impossible to describe all the little devices that may be employed; the operator can only learn how to deal with the difficulties under consideration by experience in operating and by visiting the clinics of colleagues in this and other countries. Still there are one or two matters in connection with technique which must be referred to. And first of all should be mentioned the advantage of working down the posterior wall of the uterus at as early a stage as possible in the operation. The adhesion

of an inflamed tube and ovary to the posterior surface of the uterus is seldom extremely intimate, and the separation is usually easily accomplished. In that way it is possible to work round the sac and attack it from all sides. Another procedure often useful is to clamp and divide the tube at its uterine origin, and work down in the broad ligament, so as to separate and raise up the pyosalpinx from below.

If the tubes are very tensely filled and likely to burst while they are being separated, it is an advantage to aspirate them. But the objection to simply plunging an aspirating needle into the sacs is that a continuous leaking occurs through the puncture. To avoid this the tube may be divided close to the uterine end, and aspirated through the sclerosed portion of the isthmus; the isthmus is then clamped or ligatured. It is not advisable to empty the sac completely for it is easier to separate it from its adhesions to bowel if it is moderately distended.

In cases where a loop of small intestine is very intimately adherent to the sac it is better not to waste time in prolonged efforts at separating the bowel, but to clamp and remove the adherent loop with the pyosalpinx, and perform an end-to-end or lateral anastomosis. Injuries to the rectum are more serious, and are apt to be overlooked. Now in all cases in which the pus-sac has been very intimately adherent to, and with difficulty separated from, the rectum or the pelvic colon, these parts should be carefully examined. In such cases, after the operation is completed and there remains only the abdominal wound to close, the bowel-wall may be tested by running a pint or more of saline solution into the rectum. If there is no break in the lumen of the bowel the pelvic cavity remains dry; if there is a break fluid escapes through the aperture.

The actual method of repairing injuries to the pelvic colon is dealt with in another article (*vide* Vol. III. p. 574). But even although the actual repair of the injury is carried out in the most approved manner, in bad cases of injury a good result will seldom follow unless the pelvic cavity is drained. Naturally the majority of operators drain through the vaginal vault. But even when that is done, one is sometimes disappointed. In such cases it may improve the patient's prospect of recovery to over-stretch the sphincter ani and insert a large-bored rubber tube surrounded with gauze into the rectum.

After the tubes are separated they should be removed. The vessels are secured at the upper part of the infundibulo-pelvic ligament, and close to the uterus.

When the condition of the pelvis is examined after the operation one is struck by the extent of the raw surfaces and the loose position of the uterus. In many cases nothing can be done for the raw surfaces because there is no loose peritoneum with which to cover them, and the stumps of the infundibulo-pelvic ligament and

uterine ends of the tubes cannot be brought together. Use, however, may often be



FIG. 274.—Partial hysterectomy. Half of uterus and both ovaries are conserved. (Blair Bell.)

made of the round ligaments, and a loop of them brought over the uterine stump of the tube. The 'flopping' uterus should be ventri-fixed or the round ligaments

employed to maintain the organ in a forward position if the operator prefers that to ventri-fixation. Personally I believe that ventri-fixation is the best, as the round ligaments are not sufficient to prevent the uterus slipping back into the old position of retroflexion.

The only other matter for consideration is the question of drainage. Every

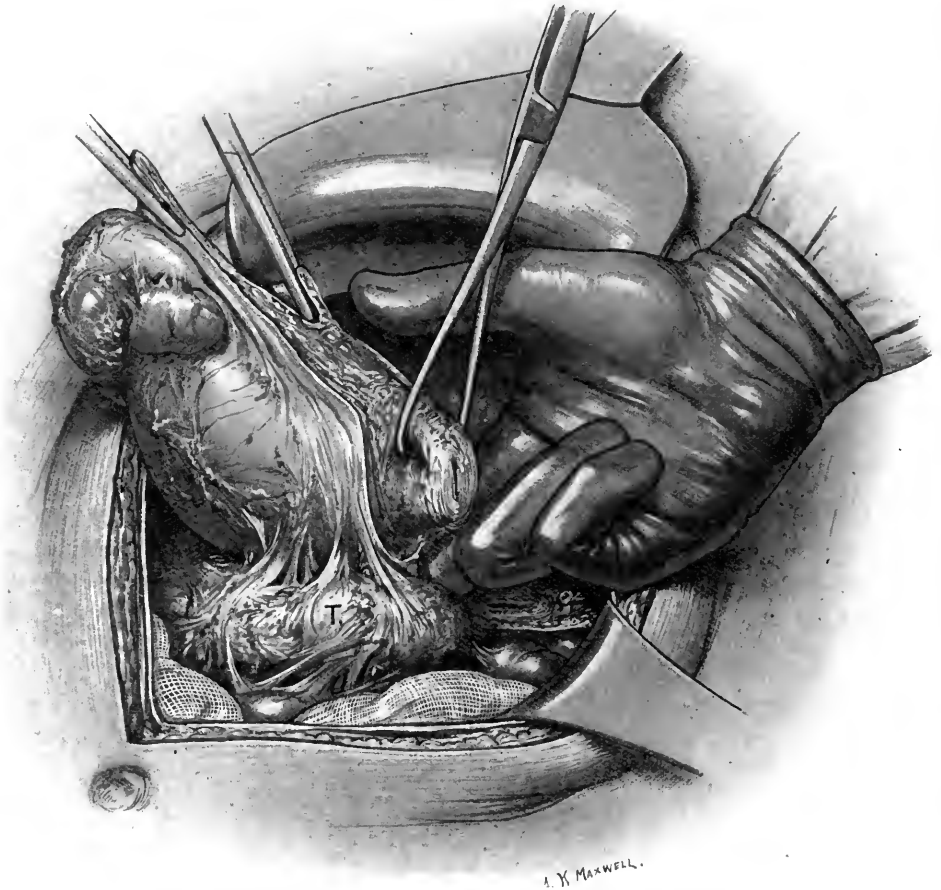


FIG. 275.—The operator has separated the connections of tube and uterus on one side, and has cut across the cervix ; he is now attacking the other pyosalpinx from below.

operator has his own views of the matter. Personally I always drain if any pus is spilled, or if there is any oozing which cannot be absolutely controlled with ligatures. Drainage is best carried out through the posterior vaginal fornix, and the gauze should not be removed until the third or fourth day.

Hysterectomy and Salpingectomy.—In simple cases the steps of the operation

after the tubes and ovaries are separated, are the ordinary steps for hysterectomy, which are fully described and illustrated in another place (Vol. III. p. 458). In

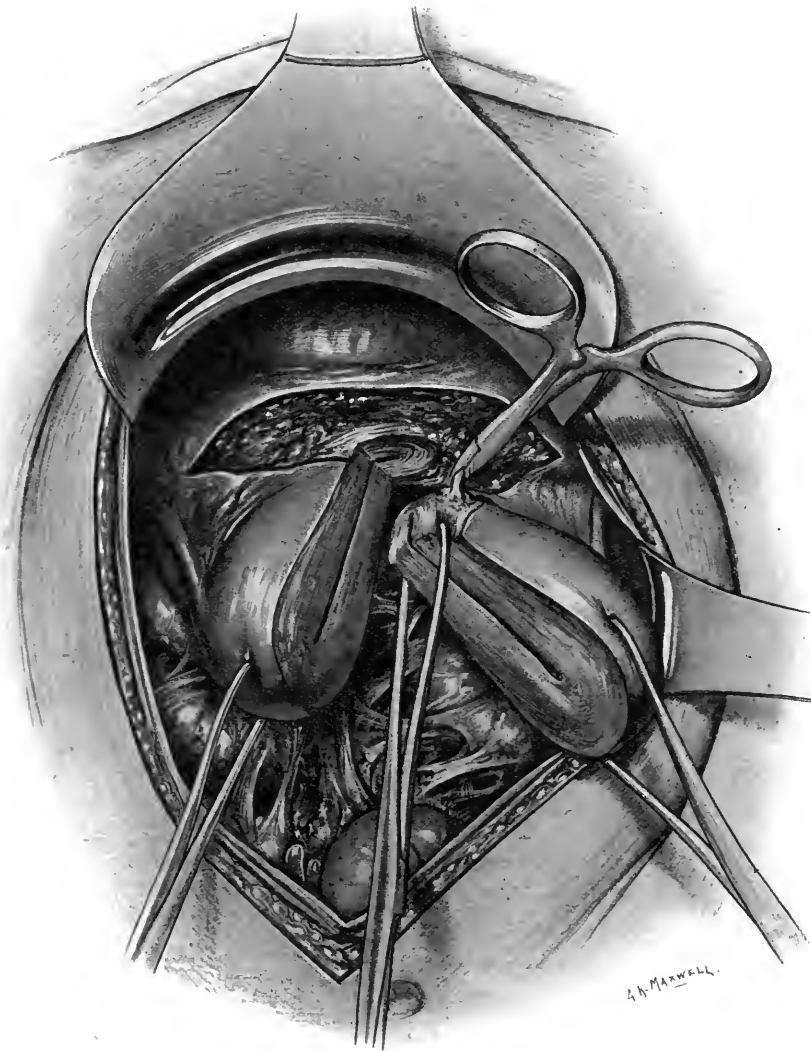


FIG. 276.—Splitting the uterus, and removing separately each lateral half with attached tube.

some cases the procedure of removing the fundal half of the uterus along with the tubes (Fig. 274), as recommended by Blair Bell, gives satisfactory results, for with the ovaries left behind menstruation continues. In more difficult cases, when the pus-sacs are large and the adhesions to surrounding structures very intimate,

other methods may require to be employed. For frequently, if the ordinary method is employed, the pus-sacs rupture and the field of operation is soiled. The

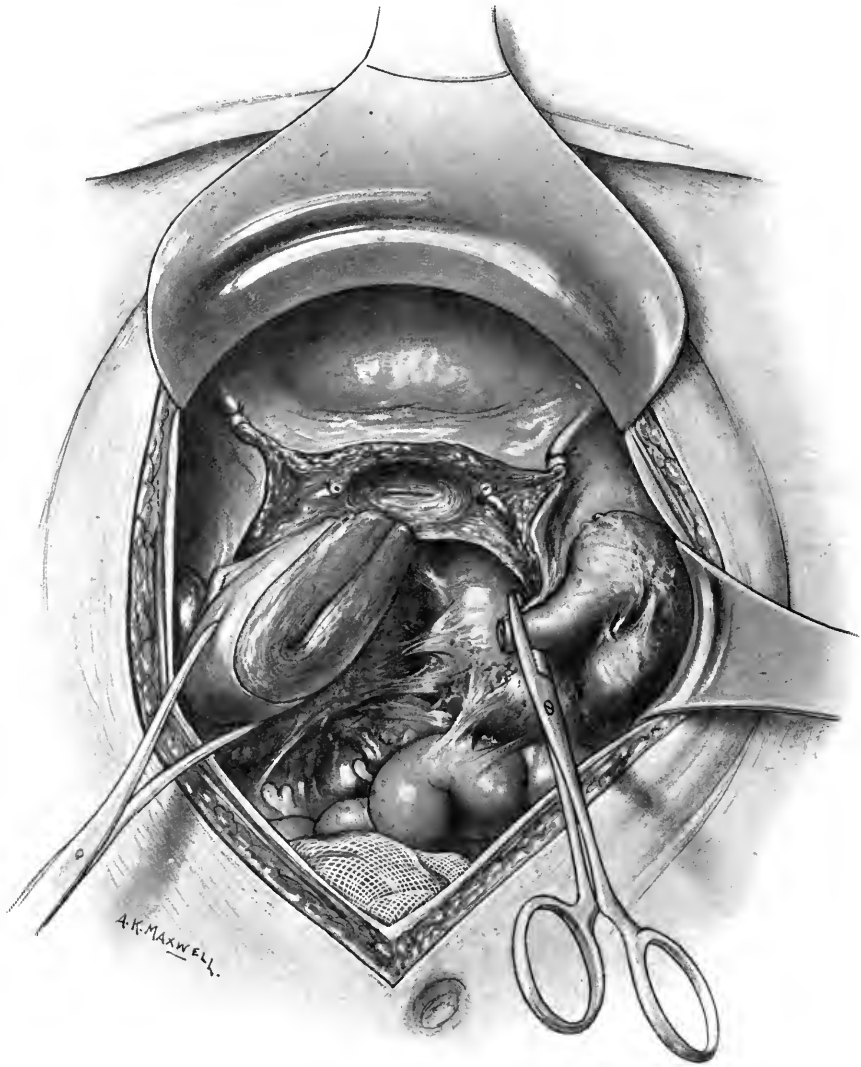


FIG. 277.—One half of uterus is removed, and the operator is now proceeding to remove the pyosalpinx of corresponding side.

pus is often sterile, and no harm results, but in a certain number of cases it is not sterile; and further, it is bad technique to rupture the sacs. The ideal which the operator must strive after is to remove the sacs and the uterus entire without spilling any pus. Now this is often very difficult to accomplish.

The first thing the operator should do when the abdomen is opened is carefully to examine the state of matters and determine his line of attack, for he will find it better to attack the condition sometimes in one way and sometimes in another. It

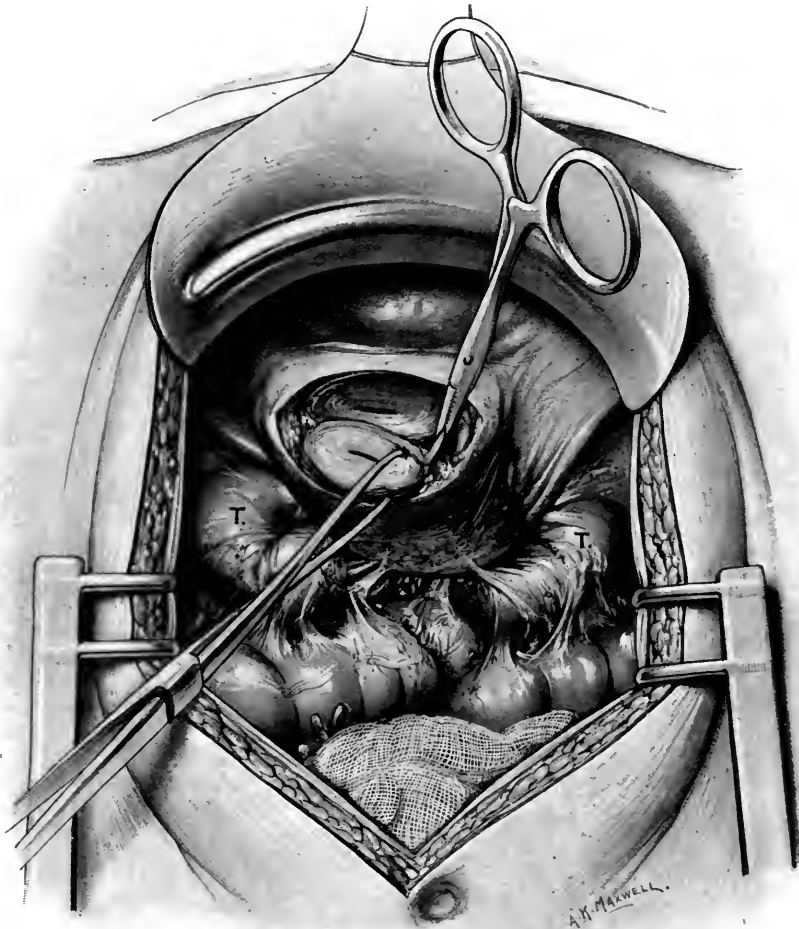


FIG. 278.—The operator having separated the bladder from the cervix, and having cut across the latter, is proceeding to attack each pyosalpinx from below. The uterus is retroverted. T=pus tubes.

is always advisable to begin with the easier side. The usual line of attack is to determine which appendages are least affected and go down that side, cut across the cervix, and then attack the difficult side from below, a method similar to the one employed when dealing with certain uterine myomata. The illustration (Fig. 275) shows how the vessels are secured by this method. When it is necessary to make

use of this method it generally means that the pyosalpinx is deeply embedded in the pelvis, and consequently there is not a little danger of injury to the ureter on that side. I have several times laid the ureter bare, and once or twice have had actually to dissect it off the pus-sac.

Another line of attack specially suitable for cases in which both appendages

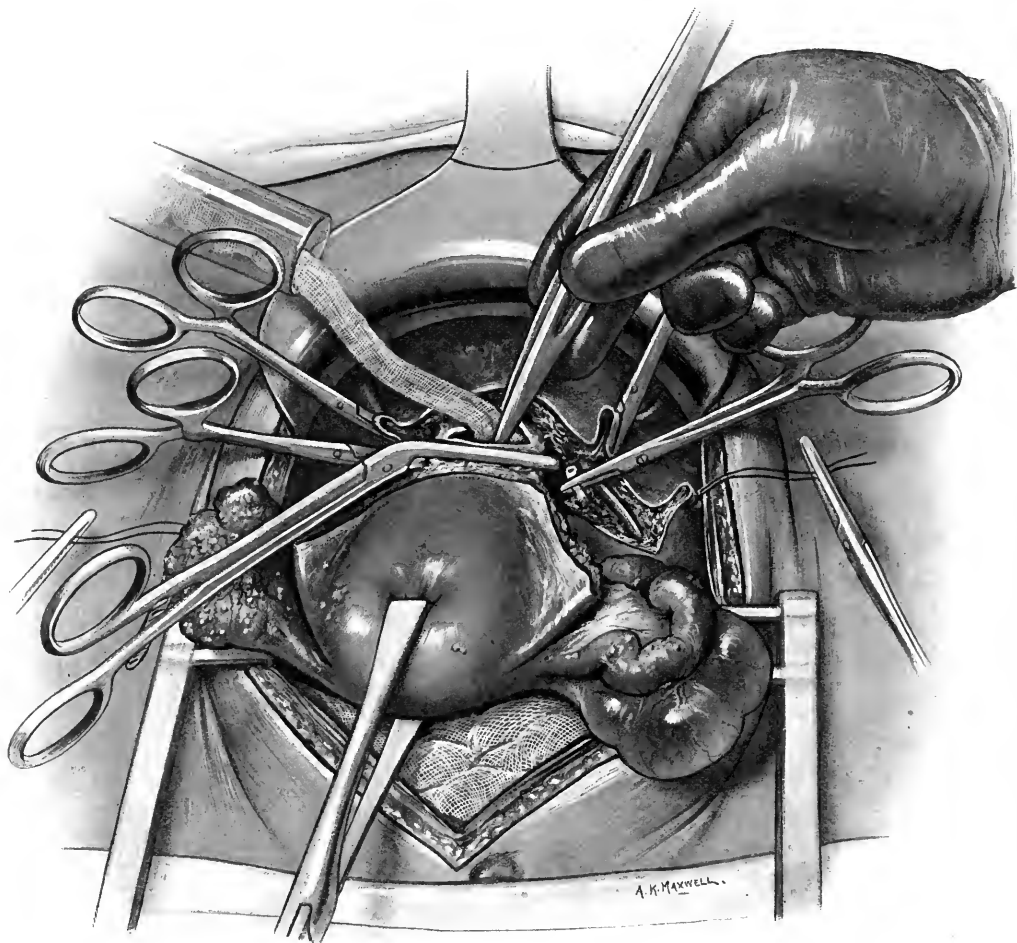


FIG. 279.—Panhysterectomy. The operator is here seen pushing gauze into the vagina, which has been cut across.

are equally affected, is to split the uterus down the middle and take out each half with its adnexa separately (Fig. 276). In carrying out this procedure it is difficult to get at the posterior uterine wall, and the space left after the uterus is split is restricted. A modification of this method is to remove the half-uterus, arresting all bleeding points with clamps, and then deal with the pus tube (Fig. 277). I have

not found this very successful, for invariably there is difficulty in controlling the bleeding, and so the whole field of operation becomes obscured.

Another method is to attack the inflammatory mass of tubes and ovaries from the front (Fig. 278). The bladder is first of all separated and pushed down, the cervix cut across, and the tubal swellings attacked from below, while traction is made upon the divided cervix. The chief disadvantage of this device is the venous bleeding from the vessels at the sides of the cervix.

Having removed the pus-sacs and uterus, with or without the cervix, and secured the vessels as described in connection with hysterectomy, and having ligated all the bleeding points, the vaginal canal should be closed and the pelvic floor covered with peritoneum if that is possible. If the surface is extremely ragged, and always if there is any oozing, or pus has been spilled, a gauze drain should be inserted, the end of which is brought out through the partially closed vaginal canal or through a counter opening in the posterior vaginal fornix if the stump of the cervix is left.

The relative merits of panhysterectomy and supravaginal amputation have not been discussed. Personally I consider panhysterectomy the better operation because the whole septic cervix is removed (Fig. 279). But this is not the place to discuss such a vexed question which, after all, cannot be considered a matter of extreme importance.

The greatest care is required in dealing with tubercular pyosalpinx. Many of these cases improve from simply opening the abdomen. The chief risk in removing tubercular sacs is the great danger of injuring the bowel. The bowel-wall invaded by tubercle is very friable, and consequently injury done to it is most difficult to repair.

PELVIC CELLULITIS

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THE term "parametritis" was given by Virchow to inflammation of the pelvic cellular tissue, but the late C. J. Cullingworth in his article on "Pelvic Inflammation" in Allbutt, Playfair, and Eden's *System of Gynaecology* (1906) gave three very sound reasons for preferring the older name of "pelvic cellulitis," and in this article his plan of keeping to that term will be followed; hybrid though it is, common usage sanctions its adoption.

As in the case of appendicitis, inflammatory pelvic swellings which frequently resulted in abscess formation, were described as *phlegmon*. The perityphlitic phlegmon of the early days of appendicitis had its counterpart in the pelvic phlegmon, and in both the cellular tissue was looked on as the primary and chief seat of the inflammation. Since the middle of the last century when, among others, Aran, Bernutz, and Goupil showed the preponderating part played by the uterine adnexa and the pelvic peritoneum in the causation and formation of these inflammatory masses, the experience of operative gynaecology has tended more and more to prove that the primary focus is only rarely in the cellular tissue. The older ideas have been slow in disappearing, and it is remarkable at the present day how frequently the diagnosis of pelvic cellulitis is made, simply because there is a large and hard inflammatory mass at the side of the uterus, when the history, clinical features, and physical signs all point to the lesion being obviously in the pelvic peritoneum. The vast majority of such swellings, more especially if they are not the immediate consequence of a labour, are due to infection of the uterine appendages.

Definition.—The first problem which confronts us in the consideration of the subject is to define Pelvic Cellulitis as a distinct entity among pelvic infections, and to decide exactly what ought to be included under this heading. This is by no

means a simple question, as some degree of cellulitis accompanies most pelvic inflammations. In the widespread forms of infection, such as follow severe puerperal sepsis, an extensive pelvic lymphangitis and cellulitis with septic thrombo-phlebitis may occur, leading to diffuse suppuration and peritonitis. Virchow described infections of this character as *erysipelas malignum para-uterinum*. In these cases the pelvic and even the abdominal tissues are too widely involved, and the clinical picture is too much that of a general septic toxæmia, to allow of their being included under so localizing a designation as that of pelvic cellulitis. The extreme hardness and fixity of the inflammatory mass which accompanies an acute outbreak in a case of chronic salpingitis or pyosalpinx is largely due to effusion into the surrounding cellular tissue; it is the cellulitis of the subperitoneal tissue which limits the movement of the peritoneum and produces the "plaster of Paris" hardness which characterizes these swellings in the acute stage. As the acute attack passes off the mass softens, becomes smaller, more movable and more defined, so that in the quiet stage it can be recognized distinctly as a swelling of the uterine appendages. If an operation for the removal of such masses is performed while there is still acute inflammation, the exudation into the connective tissue is easily noticed. The broad ligament in its upper part is thick and of an almost cheesy consistence, so that ligatures and sutures cut through it readily, and there is difficulty in getting the mass up to the abdominal incision because of the stiffness and fixity of the tissues. Hard masses of induration round the coils of intestine contiguous to the focus of inflammation, so hard as to simulate a ring-carcinoma, are also found, and the fine areolar tissue of the omentum may be swollen into a thick *plaque* of the same cheesy consistence as the broad ligaments. It is true that most of the mass formed in such cases is due to exudation and swelling in the cellular tissue, but it is secondary to the adnexal infection. Septic thrombotic lesions are also accompanied by a certain amount of surrounding cellular-tissue infiltration, but, as before, the cellulitis is in the background of the clinical picture. There is a general pyæmic condition in which the local pelvic cellulitis plays a very minor and secondary part.

The term Pelvic Cellulitis ought to be reserved for a lymphangitis and cellulitis arising primarily in the pelvic cellular tissue, and forming a local inflammatory swelling which is distinctly the principal feature in the case. On these grounds the diffuse cellulitic infections associated with a general septic toxæmia, and the cellulitis accompanying adnexal affections will not be considered here.

The Anatomical Arrangement of the Pelvic Cellular Tissue.—The pelvic connective tissue is generally held to include the cellular tissue between the pelvic peritoneum and the pelvic diaphragm, the *cavum subserosum pelvis* of Luschka.

It forms the loose connecting and supporting areolar tissue between the organs and the wall of the pelvis, and between contiguous viscera and soft structures ; it surrounds the blood-vessels and forms their sheaths ; it is condensed into strong bands and ligaments forming the aponeurosis of muscles, and the ligamentary attachments of the pelvic viscera. Infections chiefly involve the loose areolar and fatty tissue, and their spread is directed by the arrangement of the denser fascial and ligamentary planes, so that a brief review of the anatomical features of the pelvic connective tissue is necessary in order to understand the origin and extension of these inflammatory affections.

The anatomy of the cellular tissue in the pelvis has been studied by dissection, by frozen sections, and by injections. The more important ramifications are constantly under the observation of those who operate on the pelvic organs, and in the following description the points readily noticed during operations on the living body will specially be kept in mind.

The simplest method is to begin by tracing the subserous connective tissue across the pelvis from front to back. This tissue is a continuation of the sub-peritoneal layer of the abdominal wall. The peritoneum passing off the abdominal wall is closely applied to the fundus and part of the posterior wall of the bladder, but between the bladder and the symphysis pubis there is a large areolar-tissue space containing a quantity of fat, known as the *cavum Retzii*. This loose tissue extends in a thin layer outwards along the anterior pelvic wall under the peritoneum and over the fascia covering the obturator internus muscle. Between the posterior wall and base of the bladder, and the cervix uteri and vagina, is a loose areolar-tissue layer which allows the bladder to be easily stripped from these structures. This layer under the utero-vesical fold of peritoneum passes up for a short distance beneath the peritoneal covering of the anterior wall of the uterus, but quickly disappears, as is shown by the attachment of the peritoneum to the upper part of the body and fundus of the uterus becoming too intimate to allow of any movement on, or stripping from, the uterine musculature. Descending the back of the uterus the area of firm attachment does not give place to a looser attachment with intervening areolar tissue till below the level of the internal os, and on this surface the peritoneum does not strip as easily as from the anterior surface. Under the peritoneum covering the cervix and posterior vaginal wall a thin layer is present which has extensive connections with the retroperitoneal tissue at the back of the pelvis. At each side of the pouch of Douglas it is continued backwards towards the sacrum in the utero-sacral folds, and into an extensive mass of areolar and fatty tissue between the rectum and posterior vaginal wall, which in turn is continuous with the fatty

tissue in the mesentery of the pelvic colon. Posteriorly the peritoneum is closely attached to the anterior surface of the rectum, but at the sides of the bowel there is more fatty tissue. Over the sacrum the peritoneum in some places is intimately bound to the periosteum, at others a thin layer of the loose tissue may be present.

Similarly, tracing the cellular tissue across the pelvis from side to side, the subserous tissue covering the fascia iliaca is found to be continuous with the pelvic subserous tissue at the pelvic brim, and through the infundibulo-pelvic ligament with the extensive mass of loose tissue in the base of the broad ligament. As this ligamentary fold extends across the pelvis—being connected with the other side by the areolar tissue below the utero-vesical fold in front of the cervix, and to a lesser degree by the thin layer below the peritoneum covering the posterior wall of the cervix and vagina—the tracing of the cellular tissue from side to side resolves itself into a detailed description of the broad ligaments.

If the broad ligaments are thought of as being formed by the peritoneum as it passes back from the anterior pelvic wall being hung over the Fallopian tubes, it will be evident that their peritoneal relations will be much the same as those described for the uterus. The anterior and lower will be shorter than the posterior and upper sheet, which dips deeper down into the pelvis; the areolar tissue contained between the folds will be greater at the base, *i.e.* adjacent to the cervix uteri, and trifling at the summit of the fold, *i.e.* adjacent to the fundus uteri. Over the upper surface of the Fallopian tube the peritoneum is closely adherent to the tube as it is to the fundus uteri. Below the tube there is a small amount of loose areolar tissue in which run the ovarian vessels. In the upper part of the ligament, the *mesosalpinx*, there is only a little areolar tissue, just sufficient to allow the two serous layers to move freely on one another. But, like the omentum, between the layers of which there is also only a small amount of areolar tissue, infiltration with inflammatory exudate will result in considerable thickening and stiffening of the mesosalpinx. In the base of the ligament or *mesometrium* there is a very extensive connective-tissue space containing the uterine vessels and ureter. This mesometrial tissue extends down the vaginal walls where denser bands form the ligamentary attachments of the vagina, which are divided in the radical operation for carcinoma of the cervix. Owing to the lower level reached by the posterior peritoneal fold, the mesometrial space extends more deeply behind than in front. Condensed bands of its tissue, forming the sheaths of the uterine vessels, have been described as forming definite ligamentary attachments for the uterus (*ligamentum cardinale uterinum*).¹

¹ See also Article on Anatomy (p. 35).—EDITORS.

The fatty masses of cellular tissue below the pelvic diaphragm, termed by Luschka the *cavum subcutaneum pelvis* in contradistinction to the *cavum subserosum* just described, have scarcely any communication of importance with the true pelvic cellular tissue. Near the exit of the tendon of the obturator internus is a trifling gap which permits injections into the ischio-rectal fossa making their way above the pelvic diaphragm. W. A. Freund also speaks of a similar communication laterally and posteriorly, between the lateral part of the broad ligament and the ischio-rectal fossa. The round ligament and the vascular sheaths of the vessels coming through the femoral ring, the sacro-sciatic and obturator foramina, form a means of communication between the pelvic connective tissue and the subcutaneous and intermuscular connective tissue outside the pelvis.

It is important to note, in view of the frequency with which inflammation of the pelvic cellular tissue follows labour, the great increase which takes place in this tissue during pregnancy. One of the striking features to those who operate on the female pelvic organs is the ease of separation of the pelvic organs and viscera in the pregnant state owing to the increase in, and greater looseness of, the areolar-tissue planes. The broad ligaments are drawn up during the development of the pregnant uterus so that at term they are above the pelvic brim, and laterally the peritoneum does not dip into the pelvis at all. This means an enormous increase in the connective tissue between the vaginal vault and the pelvic peritoneum. This increase is such that, in cases of incomplete rupture of the uterus, the placenta and even a small foetus may be extruded into this connective-tissue space. Some doubt as to whether a rupture of the lower uterine segment does or does not open into the peritoneal cavity frequently arises, because a large retroperitoneal space which will easily admit the whole fist is opened up. It is the great increase in the cellular tissue during pregnancy, and the active physiological changes resulting in its absorption, which make its infection during the puerperium so important clinically.

The lymphatic channels which traverse these connective-tissue spaces require passing mention. The lymphatics from the greater part of the vagina, and from the cervix and lower part of the body of the uterus, pass out along the base of the broad ligament, following the course of the uterine vessels across the ureter to the internal iliac artery and its origin from the common iliac. The chief glandular station for these vessels is the hypogastric or iliac glands. Frequently a small parametrial gland is found about the point where the uterine vessels cross the ureter, and other small glands or masses of lymphatic tissue are often found in the parametrium. The lymphatics of the fundus and upper part of the body of the uterus follow the ovarian vessels by the infundibulo-pelvic ligament to the glands at the bifurcation

of the aorta and the lumbar group along the main stem of the aorta as far as the origin of the ovarian artery. Smaller lymph channels run from the posterior cervico-vaginal region in the utero-sacral ligaments to the median and lateral sacral glands. Another small channel to the inguinal glands is described as running along the round ligament from the uterine cornu. A fuller description of the pelvic lymphatics is given in the Article on Anatomy (p. 33).

Etiology.—In the great majority of cases the *streptococcus pyogenes*, often of a haemolytic type, is the infecting agent. The staphylococcus is occasionally found and other organisms, such as the gonococcus and the *bacillus coli communis*, have been found, generally in association with the two first mentioned. The severity of the infection seems to depend more on variations in virulence of the individual organism than on the variety of the infecting organism.

The possibility of the gonococcus invading the lymphatics and cellular tissue has given rise to some controversy. Wertheim argued that this could occur, whilst Bumm looked on the cellulitis as the result of a mixed infection, and mentioned the cervical erosions which so frequently accompany gonorrhoea in the female as the possible mode of entrance of other pyogenic organisms. It has not been proved that the gonococcus, by itself, is capable of producing a primary pelvic cellulitis, and an uncomplicated gonorrhoea does not give rise to the same inflammation and abscess-formation as is seen in a streptococcal infection.

By far the most common mode of ingress of the infecting organism is through injuries to the cervix and vaginal vault during labour. The great increase in the amount of the pelvic cellular tissue which occurs during pregnancy has already been mentioned. Lacerations opening into the extensive spaces at the base of the broad ligament and elsewhere, especially if accompanied by a lessened local resistance from bruising of, and haemorrhage into, the tissues, will readily afford entrance to organisms. But just as small and scarcely visible scratches on the finger may give rise to a widespread cellulitis of the arm, so also quite trifling injuries of the uterus and vagina, if infected, may lead to extensive pelvic inflammation. These injuries may occur either as the result of instrumental labour or in natural delivery, but cellulitis is more common in the former, because more extensive laceration is likely to occur and the chances of infection are greater. After abortion, on the other hand, this form of pelvic inflammation is rare, and an ascending infection of the tube and peritoneum is the usual course of the infection in such cases. There is not the same chance of injury during the passage of a small ovum, and the development of the connective tissue has not reached the same extent as at full term.

Operations on the pregnant and non-pregnant uterus involving extensive opening

up of the connective-tissue planes, especially in infected cases, are liable to be followed by an inflammation in which cellulitis plays the chief part. A not uncommon instance of this is the removal of the uterus for carcinoma of the cervix by Wertheim's method, as not only is there very extensive opening up of, and injury to, the cellular tissue, but there is also present a sloughy ulcer difficult to disinfect, which provides an infecting agent. The removal of a sloughing submucous fibroid would be another likely source of cellulitic infection, and so also would rapid dilatation of the uterus, in cases in which a purulent discharge was present, or in which the uterine cavity was already infected. Amputation of the cervix is another operation leading to extensive opening up of the cellular tissue.

Pathological Anatomy.—The organisms invade the lymphatic channels, and this is followed by hyperaemia, small-celled infiltration, and serous effusion. This gives rise to a soft swelling which later becomes hard from the formation of a more fibrinous exudate, generally limited at first to the base of the broad ligament of the involved side. In the milder cases in which resolution soon occurs it may not be more than this, but in the more serious cases there is a considerable fibrinous exudate, which becomes very hard—almost bone-like in consistence, and may form a very extensive mass in the pelvis. Most commonly extension takes place forwards and outwards to the antero-lateral pelvic wall and iliac fossa, or backwards along the utero-sacral folds to the pararectal and prevertebral connective tissues; it may also spread forwards to the connective tissue at the base of the bladder and so to the anterior pelvic and abdominal walls. Indeed the exudation may spread in almost any direction along the cellular-tissue planes, and it frequently follows the sheaths of the vessels. In rare cases it may follow the round ligament to the external abdominal ring. It is exceptional for the broad ligament on both sides to be affected, but this may occur from bilateral laceration, or from the infection spreading round the cervix from one side to the other.

The inflammatory exudate may undergo absorption or may go on to suppuration. In the milder infections with a serofibrinous exudation, complete resolution usually occurs. Large masses of fibrinous exudate may also completely disappear without leaving any evidence of damage to the tissues.

In the most severe infections suppuration occurs with the formation of an abscess-cavity. Commonly there is only one cavity, though it may arise from the conjunction of several foci of suppuration, but occasionally multiple abscesses may occur. Most of the cases with multiple foci of suppuration are thrombotic in origin and approach in character the septicaemic cases, with diffuse suppuration in the pelvis, mentioned before as belonging to a different category from the simple cellulitic abscess.

In the ordinary cellulitic abscess fatty degeneration with breaking down of the infiltrated tissue takes place, generally somewhere about the centre of the mass, and round this area of softening is formed a zone of brawny infiltration which advances in front of the suppuration, and in turn breaks down into the abscess cavity. The direction in which this infiltration spreads has already been mentioned. In the common case of involvement of the base of the broad ligament extending out to the pelvic wall, the infiltration will appear beneath the anterior layer of peritoneum above Poupart's ligament, forming a large hard mass parallel to the ligament, and sometimes filling up the iliac fossa to the level of the anterior superior spine. The skin becomes brawny and oedematous, and later fluctuation and the reddened, shiny appearance of the skin show that the abscess is pointing. The earliest evidence of the position in which the pus is coming to the surface is the discovery of an area of softening in the general brawny induration. Besides the common situation above Poupart's ligament, which Cullingworth found in 18 cases out of 22, the exudation may pass forward at the side of the bladder to the anterior abdominal wall, and reach the surface somewhere between the pubes and umbilicus. Or it may extend outwards and backwards along the uterine artery to the pelvic brim, iliac fossa, and loin, the abscess pointing above the iliac crest. More rarely the pus follows the femoral vessels and points in Scarpa's triangle, or escapes by the sciatic notch along the sheath of the posterior division of the internal iliac artery and forms an abscess in the gluteal region. Other unusual situations for the discharge of pus are—through the ischio-rectal fossa to the perineal region, through the obturator foramen to the inner side of the thigh, along the course of the ureter to the perinephric fat and loin. Rupture of an abscess into the peritoneal cavity is extremely rare. It is not unusual for a certain amount of local peritonitis to accompany a cellulitic infection, thus causing extensive pelvic adhesions, so that if rupture did occur a general peritoneal infection is unlikely. A local intraperitoneal abscess in the pelvis, shut off from the general abdominal cavity by adhesions, would result. A few instances have been recorded, however, of intraperitoneal rupture of a cellulitic abscess being followed by a general peritonitis, so that such a termination cannot be entirely excluded. Fatal peritonitis has also been described from extension of infection to the peritoneum without actual perforation.

Cellulitic abscesses rarely open into viscera or vagina. The bladder is occasionally the seat of discharge; pus discharged per rectum is almost invariably from an intraperitoneal abscess, and the vagina, owing to the resistant nature of its walls, is rarely the site of rupture of any variety of pelvic abscess. Patients frequently give a history pointing to the evacuation of an abscess *per vaginam*, when no trace

of a sinus or other physical evidence can be obtained. These cases are generally the result of the collection or "pooling" in the uterus or vagina of a purulent discharge which escapes with a gush on the patient's rising from a recumbent position, frequently on getting up in the morning.

The amount of exudation in a pelvic cellulitis is very variable, from a small mass at the base of the broad ligament to a large swelling filling up one or both sides of the pelvis and extending up into the abdomen. No doubt many of the minor cases are overlooked, especially if they occur as part of a general puerperal infection and subside with the fever. Occasionally the original site of the effusion may clear up while extension continues at a distance from the uterus. This condition was termed *remote parametritis* by Matthews Duncan. Suppuration may occur in the remote exudate.

Statistics as to the frequency of abscess formation in cellulitis are untrustworthy. It is impossible to be certain that the inflammatory masses are not intraperitoneal, and, as mentioned above, many of the slighter degrees of cellulitis are overlooked. Arnold Lea says suppuration occurs in one-third of the cases, F. v. Winckel reckons 18 per cent, and Olshausen only 1.2 per cent.

Generally some weeks elapse before definite evidence of pus formation or pointing is obtained. Cullingworth stated that the earliest period at which he had known pointing to occur was five weeks, and the latest fourteen after delivery, and he gave the seventh to the twelfth week as the usual time. Arnold Lea says six to eight weeks from the commencement of the illness.

The amount of pus varies greatly. In the common puerperal cellulitic abscess opening above Poupart's ligament there is generally a considerable quantity of thick odourless pus. In the deeper abscesses a small focus in a hard mass of exudation may be all that is discovered. The pus is generally thick and sweet, but secondary infection from bowel may result in stinking pus being evacuated. When actual communication with bowel or bladder is present the pus is very offensive, but, as already mentioned, such communication is rare with the true cellulitic abscess. Serous pus in large quantity, with flocculent matter and lymph, may be taken to indicate that the abscess is not wholly cellulitic. It is probably largely or entirely intraperitoneal in origin.

The abscess usually breaks through a small opening, and if the pus escapes freely the sinus soon closes and the induration rapidly disappears. If the drainage is imperfect there may be retention of pus and further induration. The general rule is that after evacuation the cellulitic exudate rapidly subsides. With a free opening and good drainage an abscess in the connective tissue will soon close. A persistent sinus means that some complication must be present to keep the track

open—communication with a viscus, with a suppurating mucous tract, such as a pyosalpinx, or with a cavity with a non-collapsible wall and pyogenic lining, such as an ovarian abscess; dead bone and foreign matter are other possible causes of a persistent sinus. Cullingworth was very emphatic on this point in his article on "Pelvic Inflammation" already referred to, and as experience since that article was written has tended to confirm his teaching, his actual words deserve repetition: "I have never myself yet seen a troublesome sinus result from opening a cellulitic abscess in the pelvis on the surface of the body; and I strongly suspect that the cases in which such sinuses have occurred have not been cases of cellulitic abscess, but of suppurating ovarian cyst or of other non-cellulitic form of pelvic suppuration. Similarly cellulitic abscesses are said to burst into the rectum, vagina, and bladder, and to form fistulae in consequence. I believe this assertion to be, generally speaking, ill-founded. It must be a very rare occurrence for cellulitic abscesses to open into these organs; the abscesses that commonly open into them are the result of suppuration in the tubes or ovaries. It is easy to understand that such abscesses will not infrequently be followed by fistulae. But under ordinary circumstances a true pelvic abscess, that is a cellulitic abscess, discharges its contents and disappears."

It is also remarkable how little scar tissue is left after the healing of these connective-tissue abscesses. No doubt this is due to the fact that the loose cellular tissue is abundant and easy of replacement, so that even extensive destruction by suppuration gives rise to little in the way of cicatrization and contraction. The fixity and extensive displacement of the pelvic organs often described are rarely seen, and probably most cases in which this has been noticed are complicated by salpingitis and chronic pelvic peritonitis.

Pelvic cellulitis may be complicated by femoral thrombosis and phlegmasia. The more severe of such cases may be placed in the category of a septic thrombophlebitis with accompanying cellulitis, but some are undoubtedly due to the compression of the veins by inflammatory exudation and thrombosis of the vessels in the broad ligaments extending to the iliac and femoral vein. Especially if the lesion is accompanied by lymphatic obstruction, extensive oedema and infiltration of the thigh and leg will result.

Chronic pelvic cellulitis does not occur as a sequel to the acute disease, nor apart from some other infective pelvic lesion which will keep up a chronic inflammation in the contiguous cellular tissue. The most common provoking cause is an infection of the uterine appendages, and it is often difficult to decide in such cases where the original trouble lies, until the induration in the cellular tissue has subsided. A chronic

cellulitis has been described by W. A. Freund under the title *parametritis chronica atrophicans*, in which, with indefinite nervous symptoms (sacrodynia, coccygodynia, *mittelschmerz*, etc.), physical signs of chronic metritis with a knotty exudate and scarring in the vaginal vault and base of the broad ligament, are discovered. The nervous manifestations continue, and a general atrophy of the inner genitalia, analogous to that following the climacteric, occurs. The condition seems to be a very mixed one, and clear proof of a chronic inflammatory process in the cellular tissue is entirely wanting. The chronic posterior parametritis, followed by pathological ante flexion of the uterus, to which B. S. Schultze gave so much attention, is now recognized to be of no clinical importance and is deserving of no further mention.

Frequency.—The frequency of primary cellulitis relative to other forms of pelvic infection is almost impossible to estimate accurately. We are faced with the great difficulty of distinguishing between a true infection of the cellular tissue and other forms of infection in the pelvis, chiefly those of the pelvic peritoneum or uterine appendages, and thrombotic lesions, especially as, frequently, all varieties may be present at the same time. Some degree of cellulitis invariably accompanies a pelvic infection, and a variable degree of peritonitis may accompany a severe cellulitis, so that the structure to which the predominant share in the infection is ascribed depends on the personal predilection of each individual observer.

Wilson analysed 1092 cases of pelvic inflammation, forming 12 per cent of the total number of gynaecological cases seen by him at the Birmingham General Hospital, and found that 113 suffered from acute, subacute, or chronic pelvic cellulitis, and 979 from pelvic peritonitis, adnexal disease, etc.; in other words, he termed over 11 per cent of his cases of pelvic inflammation as chiefly infections of the cellular tissue. Lock, in an analysis of 118 cases of pelvic inflammation admitted to St. Thomas's Hospital in 1911,¹ says: "Thus out of 118 cases of pelvic inflammation we find only one of acute cellulitis going on to abscess formation; two cases with cystic masses in the broad ligament; one case of typical cellulitis that cleared up without abscess formation, and two very mild cases. Thus we have six cases of true primary pelvic cellulitis, two of very mild degree. We have six cases of thrombophlebitis of uterine or ovarian vessels, and one more, of a similar nature, classified as puerperal pyaemia." During the five years 1908–1912 a little over 7 per cent of the cases of pelvic inflammation admitted to the Gynaecological ward at St. Thomas's Hospital were described as cellulitis. Four hundred and eleven were classified as salpingitis, pyosalpinx, ovarian abscess, etc., and seventy-five as pelvic peritonitis, and only thirty-eight as cellulitis. That this classification is a very rough one is well shown

¹ *Journal of Obst. and Gyn. of Brit. Emp.*, 1912, vol. xxii. p. 1.

by the remarks in the Registrar's report on the ten cases recorded as cellulitis in 1909. Of these, one patient was readmitted for suppurating cyst of the ovary, and out of three cases in which abscesses were opened and drained, in one the uterus and appendages were ultimately removed and in another the appendages of one side. In another case which ended fatally the abdomen was opened and the appendages of the left side removed; at the operation marked cellulitis of the left broad ligament was found. The abdomen was drained, but death occurred from general peritonitis. Another case was considered as chronic pelvic cellulitis, the onset dating from a curetting operation six months previously. These remarks indicate the difficulty of estimating the frequency of the cellular tissue as the primary and chief seat of infection. In four out of ten cases, infection of the uterine appendages was present, was the cause of the continuance of the pelvic inflammation, and ultimately led to operation for its removal. In a fifth case (chronic inflammation following on a curetting, for which no other operation was performed), it is more than likely that the inflammation was kept up by chronic adnexal mischief. In other words, in half the cases classified above as cellulitis it is very doubtful if the cellular tissue was the primary seat of the trouble. All statistics are vitiated by the tendency to classify inflammatory masses as cellulitis upon insufficient evidence.

Symptoms.—So many cases of pelvic cellulitis originate in puerperal infection that the early symptoms of the local disease are frequently masked by a variable degree of toxæmia, and there is some difficulty in deciding what symptoms are to be ascribed to the general and what to the local infection. Localization is determined by the degree of virulence of the infecting organism, and by the general and local resistance of a patient's tissues. Some reaction at the seat of infection will occur in all but the most severe septicaemias, but often it will be so trifling and play so small a part in the disease that, even if recognized at all, it will be relegated to the background of the clinical picture. In an article like this devoted to an inflammation of a specific portion of the pelvic tissues, only the symptoms peculiar to, and arising from, this definite infection require consideration, but it must be borne in mind that in actual practice it may not be possible, at any rate at first, to differentiate these symptoms from those of the general condition in which they arise. The type taken as illustrative of pelvic cellulitis will be those cases in which a general septicaemia has not occurred, or if so, has died out and left a local infection of the pelvic connective tissue. A good example would be a puerperal infection in which, after evacuation and disinfection of the uterine cavity, a remission of symptoms occurred, with later a recrudescence owing to a local infection of the pelvic cellular tissue. Thus the symptoms of an acute localized cellulitis may be present three

or four days after delivery or may be delayed as late as the second week. The fever, which may have been present soon after delivery, will either have diminished for a time and increased again with the development of the local lesion, or if there has been little or no fever a rising temperature, usually with morning remissions, will mark the commencement of exudation into the cellular tissue. The local inflammation is sometimes ushered in by a rigor, but repeated rigors are uncommon and point to a septic thrombophlebitis. The pulse-rate rises and falls with the temperature, but a persistently high pulse-rate is unusual and should lead to a suspicion of a general septic infection or peritonitis. Pain is not a marked feature as in pelvic peritonitis. In slowly developing exudates it is entirely absent; when the effusion develops rapidly and is extensive there may be pain in the iliac fossa, aggravated by movement, shooting down the legs and up to the loin. If the exudation extends into the iliac fossa, the leg on that side is generally drawn up to relax the psoas and iliacus muscles, the sheaths and connective-tissue bundles of which are involved in the inflammation. Defaecation and micturition may be painful; diarrhoea with the passage of mucus by the bowel, and signs of cystitis will indicate the extension of the inflammation to the rectal and vesical walls.

The general symptoms are those of a mild septicaemia; sleeplessness, loss of appetite, thirst, headache, and constipation, with a furred tongue, dry mouth, and a sallow earthy complexion, are usual, although in the milder cases the general health may be little affected. Profuse sweating may occur with remissions of fever, but this again would point rather to septic thrombosis and pyaemia. More commonly the skin is harsh and dry. Except in cases going on to suppuration the fever gradually subsides in the course of a week or ten days, but occasional slight rises of temperature on getting up are not uncommon.

Physical Signs.—On examination some evidence of uterine infection is generally found. The lochia may be offensive or purulent; the uterus tender and larger than usual for the period of the puerperium reached. Lacerations of the cervix and vagina are frequently discovered. The physical signs of exudation in the base of the broad ligament are not usually found till a few days after the onset of symptoms. At first the oedema and infiltration of the tissues give rise to little more than a feeling of greater resistance and tenderness in one vaginal vault as compared with the other, but as the effusion becomes more fibrinous in character a definite, hard, unyielding mass running laterally from the uterus, and forwards to the anterior pelvic wall will be recognized. This mass becomes harder and more fixed, and causes depression of the vaginal vault on that side. Owing to the involvement of the loose tissue round the vagina, the vaginal wall cannot be moved over the mass, and

for a like reason the mass becomes fixed to the pelvic wall. The uterus is immobile, and, as is usual in one-sided inflammatory exudates, it is slightly pushed over to the unaffected side. The pouch of Douglas and the posterior part of the pelvis may be quite free. As the mass increases in size it passes forward to the tissue beneath the reflection of the peritoneum on the anterior abdominal wall, and forms a broad band of induration running parallel to Poupart's ligament, which may fill up the iliac region to the level of the anterior superior spine. Sometimes the exudation extends forward in the precervical tissue, occasionally surrounding the cervix as a thick collar of indurated tissue, but more commonly forming an area of hardness in the retropubic region and extending up beneath the anterior abdominal wall. In rare cases the exudation extends backwards in the retrocervical tissue and uterosacral ligaments to the pararectal tissue. In such cases the rectal wall is felt surrounded by a hard band of induration which extends forward on one or both sides of the pouch of Douglas to the cervix, leaving the pouch itself free.

Differential Diagnosis.—The chief difficulty in diagnosis is to differentiate these exudations into the cellular tissue from the much commoner intraperitoneal masses formed around the inflamed uterine appendages.

The clinical history is of great importance. Cellulitis as the primary factor may be excluded almost with certainty from all cases in which a recent history of labour, and that at full time or nearly so, or of some operative procedure by which the cellular tissue might be opened up, is absent. Cases, then, in which this history is not obtainable, and also cases with a pelvic exudate after labour which has persisted without undergoing either resolution or suppuration for three or four months, or in which recurrent attacks of acute pelvic inflammation have followed subsidence of the original infection, are almost certainly due to the presence of some infective focus in the uterine appendages.

Severe abdominal pain and tenderness, with rigidity of the abdominal wall, especially if accompanied by distension, vomiting, and difficulty in obtaining an action of the bowels, would clearly point to a peritoneal infection. Acute pain may generally be taken as indicative of involvement of the peritoneum.

Fever is usually more marked in cellulitis than in peritonitis, whereas the pulse-rate is, relatively to the temperature, higher in peritonitis than in cellulitis.

Differentiation by physical signs is very difficult in acute pelvic inflammation because commonly both the peritoneum and cellular tissue are involved, and often it is only after the acute attack has subsided that an exact diagnosis can be made. No importance can be laid on the shape of the exudate. It is often stated that appendage cases give rise to a well-defined sausage- or retort-like tumour in contra-

distinction to the more diffuse, flatter cellulitic mass. The distinctive shape of inflamed uterine appendages is only met with in chronic swellings, in the cold stage. At the time of an acute attack these sausage-like tumours become imbedded in a mass of infiltrated broad ligament, and inflamed and adherent bowel and omentum, losing their characteristic shape. All that can be said is that if, after the subsidence of an acute attack and the absorption of the surrounding infiltration, a swelling of this kind becomes differentiated from the general infiltration, it is clear that a chronically inflamed tube is the primary source of the mischief.

The uterus and indeed the whole inflammatory mass is usually more fixed in the case of cellulitic swellings, and also harder, but both these characteristics may be present in peritoneal infections from secondary involvement of the subperitoneal connective tissue.

The more important differential points in the physical signs of the two conditions are :

(a) Pelvic cellulitis is more often a unilateral, pelvic peritonitis a bilateral affection.

(b) In pelvic cellulitis the mass commonly forms in the base of the broad ligament and extends forwards to the pelvic wall ; hence the swelling occupies the anterior quadrant of the pelvis. In pelvic peritonitis the mass is formed behind the broad ligament and often extends into the pouch of Douglas ; the swelling, therefore, occupies the posterior quadrant of the pelvis, and may form a tongue-shaped extension behind the posterior vaginal wall, adherent to the back of the cervix and continuous with the main mass. If, on bi-manual examination, a certain amount of normal tissue is felt between the fingers in front of the inflammatory mass, in all probability the case is one of adnexal disease. If the posterior quadrant of the pelvis is free, and the mass occupies the anterior segment right up to the anterior pelvic wall, it is probably cellulitic. It is, however, much more difficult to make sure that the posterior part of the pelvis is free than the anterior, and in many cases of extensive peritoneal inflammation, the omentum becomes adherent to the pelvic brim in front and to the anterior abdominal wall, and is infiltrated with hard exudate, so that it cannot be said that a mass occupying the anterior segment is necessarily cellulitic. The crucial test is the absence of exudate in the posterior quadrant.

(c) The presence of a *fluid* exudate in the pouch of Douglas makes a peritoneal infection certain. If it is extensive the uterus may be pushed forward and an elastic swelling felt behind it. The presence of any swelling in this situation is indicative of peritonitis.

Cellulitis in the retrocervical tissue and in the posterior part of the pelvis is

so rare that the presumption is that all inflammatory swellings in this part of the pelvis are intraperitoneal in origin. Some importance has been ascribed to the presence of a hard ring round the rectum as a sign of cellulitis, but so far from this being the case it suggests rather a peritoneal infection. In all chronic peritoneal inflammations the bowel wall is liable to become involved in a mass of exudate, sometimes rendering it so hard and unyielding as to simulate a ring carcinoma. This is especially liable to be the case near the focus of infection, *i.e.* about the abdominal ostium of the Fallopian tube. This condition of induration of the bowel wall is so frequently met with in operations for inflamed uterine appendages and, when present, impresses itself so forcibly on the operator by the liability of the stiff brittle bowel wall to injury and the ease with which sutures cut through, that there is no need to emphasize it. It is only when the pouch of Douglas is empty, and the exudation is distinctly felt extending backwards along one or both uterosacral ligaments to the rectum, that the induration round the bowel wall can be ascribed to a primary cellulitis.

There is another form of puerperal infection which is often wrongly described as pelvic cellulitis, and that is an intraperitoneal abscess in the iliac fossa arising in the first two or three weeks of the puerperium. Owing to infection of the appendages occurring before involution is far advanced, they become adherent at the pelvic brim and a large abdominal mass is formed in this region. There is usually little evidence of inflammation to be found in the pelvis itself, but the mass, though situated a little external to and above the usual situation of a cellulitis, is commonly described as such. I have seen several cases in which, after the opening and drainage of a puerperal abscess in the iliac fossa, operation has been necessary later for tubo-ovarian abscess. The signs distinguishing these intraperitoneal abscesses are that they arise early, and fluctuation is detected before the usual time for a cellulitic abscess to reach the surface, *i.e.* within a month or less of delivery instead of after six or eight weeks. The pus is generally larger in amount and of a more watery character than in the cellulitic abscess, and frequently contains flocculent masses of lymph-like material. Owing to the oedema and inflamed condition of the abdominal wall it is not always possible to be certain at the time of opening whether the pus is from an intra- or an extra-peritoneal collection, but the absence of the cartilaginous induration which surrounds the cellulitic abscess is suggestive of an intraperitoneal origin.

Septic thrombosis of the pelvic veins may occasionally give rise to a tender circumscribed swelling, or a thickened cord extending from the uterus to the pelvic wall. Some exudation almost always surrounds these thrombosed veins and so

adds to the size of the swelling. High fever of a remittent type with rigors and heavy sweats, and other pyaemic symptoms, are generally present; oedema of the leg, and pain along the course of the femoral vein, are also possible accompaniments. The small size of the pelvic mass and the serious character of the general symptoms will suggest a graver cause than a simple cellulitis.

Errors in diagnosis are not likely to arise between cellulitis and other conditions in the pelvis unless they happen to be post-partum or post-operative complications. *Appendicitis*, like adnexal disease, may give rise to pelvic inflammation, and, in those cases in which the appendix hangs down into the pelvis and causes a pelvic abscess, may result in extensive cellulitic thickening of the broad ligament. A history of previous attacks may suggest the origin of the inflammation, but reliance must chiefly be placed on a careful investigation of the clinical features of the case; if there is a pelvic swelling it will probably be behind the broad ligament and will therefore suggest a pelvic peritonitis.

A *psoas abscess* may develop during the puerperium. The history, the chronic course, and the signs of vertebral disease would serve to distinguish it.

Apart from other inflammatory affections in the peritoneum, carcinomatous infiltration, pelvic myomata, and ovarian tumours, and blood collections due to extra-uterine gestation, may possibly give rise to difficulty in diagnosis.

Malignant infiltration of the pelvic cellular tissue may give all the physical signs of cellulitis even to a slight continued fever. The occasions on which difficulty in diagnosis would arise must, however, be very rare. The primary growth in such cases is almost invariably in the cervix uteri, and, when the stage of infiltration has been reached, it ought to be quite unmistakable. Instances, however, have been recorded in which dilatation and curetting have been done for metrorrhagia in malignant disease of the uterine body without the true nature of the case being recognized, and have been followed by rapid and widespread diffusion of the growth in the pelvis. The induration has then been ascribed to post-operative cellulitis.

Pelvic tumours are also liable to cause error, especially if they have not been recognized before labour, and if they give rise to acute symptoms after labour from inflammation, torsion of the pedicle, or bruising. The most probable case is the rare one of a subserous myoma in the broad ligament which has become infected, or has begun to undergo degenerative changes. Torsion of the pedicle of an ovarian cyst is well known as likely to occur after labour; the cyst forms a hard, tender, pelvic swelling owing to the engorgement of its tissues with blood. A pelvic dermoid cyst, past which the head has been forced during labour, may form a similar swelling. All these tumours may give rise to a hard, tender mass

in the pelvis with some fever and increase in the pulse-rate, and an accurate diagnosis can only be made from the clinical history and by a thorough examination under anaesthesia, if need be. Except in the case of an intraligamentary myoma, the other tumours are more likely to be confused with a peritoneal than with a cellulitic inflammatory mass. Pelvic haematocoele, and the much rarer haematoma into the broad ligament, are scarcely likely to be confused with a cellulitic exudation. The history of the case, the absence of a recent confinement or operation in which the cellular-tissue planes may have been opened, and the sudden onset, together with the more transient effects on the pulse and temperature, will serve to distinguish a blood tumour from a cellulitic infection.

Prognosis.—The localized cellulitis usually terminates in recovery. It ends either in resolution or suppuration. In the majority of cases the fever and general symptoms gradually subside, the mass diminishes in size and becomes softer, and in the course of a few weeks all trace of inflammation has disappeared. There are practically no serious after-effects. No chronic infection remains to give rise to recurrent attacks provided there is no concurrent tubal or ovarian infection, and the tendency to cicatrization, on which much stress was laid at one time, is so slight as to be negligible.

A minority of cases, as already mentioned, go on to suppuration. The presence of pus may be suspected if no drop in the temperature occurs after three or four weeks. The general health shows marked deterioration, the patient becoming emaciated, anaemic, sallow-complexioned, and depressed. The appetite is poor and the tongue dry; constipation is the rule but occasionally diarrhoea is present. Examination of the blood shows a high degree of leucocytosis with a diminution of eosinophiles. The cellulitic mass increases in size, commonly coming up over the pelvic brim above Poupert's ligament, but it may follow any of the tracks already mentioned. Naturally when some of the less usual and more devious routes are taken, especially those towards the back of the pelvis, the suppuration is longer in reaching the surface and recovery is more protracted. Not only is the period of waiting for definite signs of the presence and site of suppuration more prolonged, but extensive burrowing and involvement of contiguous structures may occur, and the evacuation and drainage of the abscess is rendered more difficult. When the abscess has been opened and good drainage established, the fever subsides at once and the patient's aspect and general condition undergo marked improvement. The rapidity with which the symptoms abate is characteristic of the uncomplicated cellulitic abscess. The sinus soon closes, unless there is some communication with a suppurating viscus or a mucous tract, and no chronic infection to give rise to

recurrent attacks is left. Some displacement and permanent fixation of the pelvic organs may result from cicatrization in cases of extensive suppuration, but this does not cause subsequent incapacity. The most serious consequences are those due to a spread of infection to other structures, such as may occur in any variety of abscess. Infection of the large venous plexuses in the pelvis, with septic thrombosis and pyaemia, is rare. Rupture into the peritoneal cavity is also very unusual, and, as has already been explained, gives rise to a local intraperitoneal abscess rather than to a general infection of the peritoneum. Rupture of an abscess in the paravesical connective tissue into the bladder will give rise to a cystitis which generally yields to treatment, but may be followed by pyelitis and suppurative nephritis.

Treatment.—It is scarcely necessary to emphasize the importance of minute attention to the principles of surgical cleanliness in attendance on cases of labour, and at operations, in the preventive treatment of pelvic cellulitis. A good technique is the best safeguard against all forms of infection. In midwifery practice too, good judgment in the adoption of operative procedures, and especially in avoiding extensive cervical and vaginal lacerations during instrumental delivery, is another important factor. The first question that presents itself in the preventive measures is the treatment of lacerations which open up the cellular tissue. Suture of these is advisable if there is serious bleeding, but it should not be close enough to allow of the retention of blood or fluid in the tissues. Unless the bleeding is so serious as to be uncontrollable otherwise than by suture, plugging the rent is the best and simplest method of treatment. This allows a free drainage, and, unless the wound is infected, rapid healing follows. Should some infection be present, as during the removal of a sloughing submucous fibroid, swabbing the wound with 2 per cent iodine in rectified spirit, and douching with 1 in 300 iodine or 1 in 500 formalin lotion after withdrawal of the plugs ought to be adopted. Sloughing of the edges of the laceration also makes this treatment advisable.

When the exudation of pelvic cellulitis is definitely recognized the treatment must be directed towards promoting its absorption, and mitigating troublesome symptoms as they arise. Except by increasing the patient's powers of resistance nothing can be done to modify the course of the disease. If the infecting organism can be isolated from the cervical discharge, an autogenous vaccine should be prepared and inoculated. In the meantime subcutaneous or rectal injections of antistreptococcic serum may be used, as the *streptococcus pyogenes* is the infecting organism in the great majority of cases. But our chief reliance in increasing the general resistance of the patient must be placed on

attention to her comfort and general well-being, and especially on careful nursing. If possible the patient's bed should be near the window, and every opportunity taken to give her plenty of fresh air. The tendency to keep the sick-room close and stuffy is one to be combated strongly. The mouth and tongue must be thoroughly cleansed, as no patient can take food well with the mouth foul. The diet must be light and easily digestible, and must be regulated by experience of what the patient can digest. There is generally some digestive disturbance, and the appetite is poor, but a great deal can be done with tempting dishes of a simple and nutritious kind, served at the moment when the patient feels most inclined to eat. As the fever is generally distinctly remittent in type it will often be found that when the temperature is at its lowest, *e.g.* in the morning, the patient will eat solid food with relish and without digestive disturbance, and that the milk and gruel foods, of which the patient quickly tires, can be reserved for the times when the fever is at its height, *e.g.* in the evening. By observation and experience of the daily variations in the patient's general condition it will often be possible to do much in widening the choice of food, and thus limiting the emaciation and weakness of the protracted illness. No restriction should be placed on the consumption of fluids; not only are they valuable in quenching the thirst, which is a frequent symptom, but they assist elimination by the kidneys and bowel. Alcohol is not to be ordered as a routine practice, but should it be found that the patient takes her food better with a little light wine or weak spirits and water, it should be allowed. Sleeplessness interferes greatly with the well-being of the patient and requires attention. Fresh air is of great assistance in promoting sleep, so is gentle massage to the limbs, shoulders, back, and neck just before the patient is composed for the night. If there is high fever and especially if accompanied by heavy sweats, tepid sponging of the whole body, and a change into freshly-aired night garments and bed linen, is advisable. No patient can be expected to sleep well in damp nightgown and sheets, and if sponging is not required, the body should be carefully dried with a towel, the nightgown changed, and the bed remade. Every effort must be made to assist sleep by such natural means, and to avoid constant recourse to sleeping draughts, though these must not be withheld when all else fails. The bowels require very careful watching, as constipation is usual, and any loading of the lower bowel aggravates the toxic condition. A pill at night or a saline aperient in the early morning, followed by an enema when necessary, is nearly always required. If diarrhoea should occur it is best not to interfere with it unless it is so severe as to exhaust the patient and disturb her rest, in which case opium in some form will be required. Antipyretic drugs must be used with caution; their prolonged administration results in impaired

digestion, increases constipation, and adds to the general depression. The frequency with which patients are seen with severe headache, buzzing in the ears, and partial deafness from large doses of quinine, or dull and depressed from a long course of antipyrin, is sufficient justification for this warning. Opium and morphia should only be used for cases attended with diarrhoea or pain which cannot otherwise be controlled, and the salicylates should be reserved for occasional use. Acetylsalicylic acid causes less depression than salicylic acid or the alkaline salicylates, but its regular administration is open to the same objections. There is no objection to quinine in tonic doses of two or three grains, and often a bitter tonic of strychnine and acid after, or of sodium bicarbonate and nux vomica before, food is helpful.

In addition to the treatment directed towards maintaining the patient's strength and increasing her powers of resistance, there is the further question of the local treatment of the pelvic exudation. So long as the exudate is entirely within the pelvis hot applications in the shape of vaginal douches, as hot as the patient can bear, *i.e.* somewhere about 115° F., may be given twice a day. Tampons of glycerine, or ichthyol and glycerine, are of little value in these acute infections and only cause the patient discomfort; indeed the disturbance they cause does positive harm. If the exudation comes up into the abdomen, heat applied by means of fomentations, electric pads, or hot-air baths is useful. When possible the hot-air or radiant heat bath should be preferred. This can best be carried out by arranging a cradle with three or four small electric bulbs over the pelvis and lower abdomen. Fomentations are most useful in the acute stages with increasing exudation and pain. The hot-air bath is especially valuable later in promoting the absorption of exudate.

Incision into the exudation before there is definite evidence of suppuration is inadvisable. Apart from the fact that large masses may undergo absorption without pus formation, a premature incision may be the starting-point of a fresh infection or may cause extension of the inflammation, and even if this does not occur little relief is likely to result as the primary focus is generally deeply placed and difficult of access owing to the surrounding infiltration. In the cases which go on to suppuration, an incision should be made as soon as there is clear evidence of the situation of the abscess. Most commonly the first distinct indication is the recognition of a soft area in the mass of induration felt above Poupart's ligament. Sometimes the matter can be evacuated through the vaginal vault, but this should only be attempted when the induration can be recognized very definitely just above the finger, and when an area of softening can be felt in it. In these cases the best method is to incise the vaginal wall first, and then push the point of a pair of artery forceps into the exudation towards the softened

area and open them when pus is discovered. Should a cellulitic mass be discovered when the abdomen has been opened in the expectation of finding an intraperitoneal abscess, it is best to drain per vaginam so as to avoid the chance of a peritoneal infection. This is generally easy, as the abdominal incision is a great assistance in locating the exact situation of the cellulitic mass and so directing the fingers in the vagina to the centre of the swelling. With one hand in the pelvis through the abdominal incision and the other in the vagina it is a simple matter to make sure of the drainage of an abscess.

If after evacuation and drainage the symptoms persist, the probability is that some other condition than simple cellulitis is present. Indeed if it is certain that the abscess drained is the only one, and that there is no retention of matter, this will certainly be the case. Also in the event of any chronic thickening in the pelvis remaining, and especially if accompanied by recurrent attacks of fever and pain, it will be clear that some infection of the uterine appendages is also present, and that an abdominal operation will in all probability be necessary.

In concluding this review of the treatment of pelvic cellulitis I would call attention to the great importance of every practitioner supervising carefully the nursing and general management of patients suffering from a puerperal pelvic infection. The number of cases admitted to hospital suffering from the effects of inefficient nursing are not as numerous as used to be, but even now patients are seen for whom no surgical operation is required, but who improve at once with no other treatment than proper care and nursing. Emphasis has already been laid on the necessity for fresh air and diet; and in regard to the latter it may be said that the tendency is to starve patients rather than overfeed them. If care is taken to select the opportune moment, fish, chicken, and even a mutton chop may be taken. Indeed, the guiding principle in the management of all such cases is to neglect nothing that will add to the patient's comfort and well-being. In cases going on to abscess formation more especially, the patient is apt to lie for long in one position and with the leg on the affected side drawn up. Bed-sores and stiff joints must therefore be guarded against, and for the latter, movement of the knee is important. The thigh should be supported by one hand and the ball of the heel by the other, and the limb straightened several times morning and evening.

SYPHILIS IN WOMEN

By ARTHUR SHILLITOE, F.R.C.S.
(London)

SYPHILIS varies in its symptoms with the sex of the patient, and it is more especially with the differences and peculiarities that characterize the attack in women that I now propose to deal.

THE INITIAL LESION

Chancres of the Vulva.—The initial lesion or chancre starts as a tiny papule which is in most cases a granuloma. In women it is seldom seen in this early stage, partly on account of the general ignorance of the disease among women, and partly because one is debarred by feelings of delicacy from discussing the situation as freely as with men; and even in cases in which the question can be discussed, the history is generally most unreliable. So that, by the time the initial lesion is seen in women, it will generally be found to be either an erosion or an ulcer.

If a section of a chancre, or better still, of the original papule, be examined, it will be found that the epithelium over it has proliferated, especially at the margins, the centre being flattened by the pressure exerted by the up-growing granuloma. A certain amount of desquamation may now take place with the formation of an erosion, which in its turn may readily be infected by the saprophytes ever present in the neighbourhood, an ulcer resulting. The initial lesion in women frequently becomes secondarily infected.

The proliferation of the epithelium is secondary to the growth of the granuloma, which is seen to consist principally of a dense infiltration of plasma-cells, which are stated by Unna to be altered connective-tissue cells, although most authorities consider they arise from lymphocytes, arranged more or less in bundles. The induration typical of a specific sore is probably due to the proliferation of the fixed connective-tissue cells, which become transformed into fibrous tissue.

So we see the organisms concerned, *i.e.* the *Treponema pallidum* or the spores

described by M'Donagh¹ according to the theory accepted, get implanted on a small abrasion or abrasions, and promptly attack the connective-tissue cells growing *in loco*; one or more granulomata are formed, the number of sores depending on the number of points infected. I have used the word "abrasion," but it should be understood that this is more often than not a mere solution of continuity of the epithelium, and therefore not obvious to the naked eye.

As an example of true abrasions and multiplicity of chancres, I saw a male patient some years ago, in whom, just previous to intercourse, the girl had caused multiple abrasions by drawing a piece of bramble across his penis. Each little wound caused by the thorns became inoculated, and later the seat of a chancre. These fused together and formed one large sore, involving most of the sheath of the organ. But the chief difficulty is, that often in women the most careful examination may fail to discover any sore. In women the sore is less exposed to sources of irritation, such as the clothes, which tend to encourage its persistence in men. If the sore be situated on the inner surface of the labia, its surroundings may prove especially favourable to its early resolution and complete disappearance. Compare this with a chancre on the inner aspect of a rather tight prepuce.

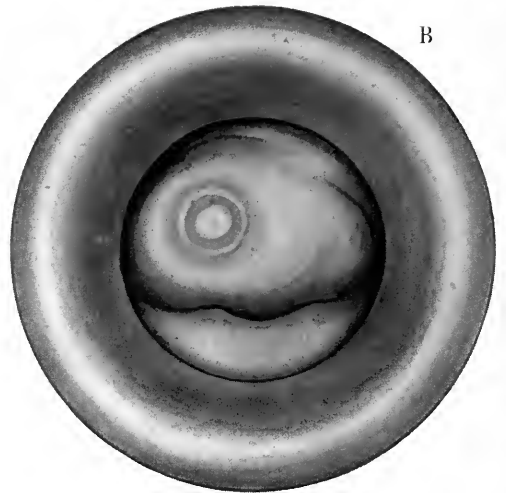
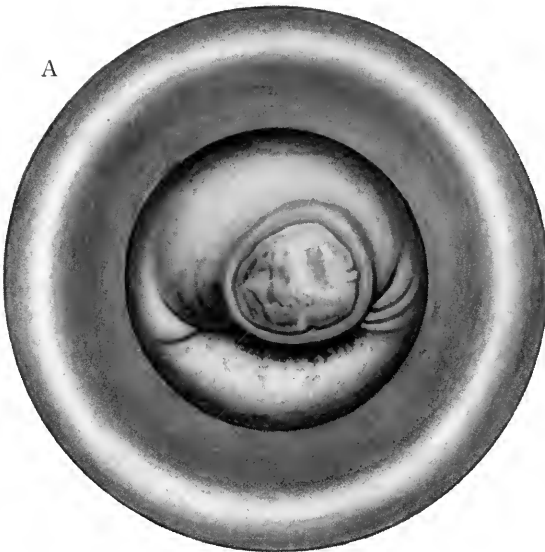
Such ephemeral sores are much commoner in spare, otherwise healthy women, who keep themselves scrupulously clean and dry, than in stout, intemperate women, who perspire freely or are not so careful. They will occasionally be found to reappear with the onset of secondary symptoms. Many a time have I been told that a small sore had been discovered a few days after intercourse, that this had rapidly cleared up under some simple ointment leaving no trace, and that nothing further had happened until the appearance of an eruption, which was *followed by* a chancre on the site of the original inflamed spot.

Many years ago I saw an analogous case in a man; a small sore developed on the glans in less than a week from intercourse. This I thought I had destroyed with pure carbolic acid and that the patient was safe, but in due course secondaries developed and also a chancre on the site of the original sore. It was a lesson I have ever remembered. Should one find it advisable to attempt to destroy a small sore that had appeared within a few days of intercourse, one must always give a most guarded prognosis. In a case of secondary syphilis the absence of a sore, especially in women, should not be allowed to influence the diagnosis; and further, one should always be suspicious of a sore appearing as long as twelve days after exposure to possible infection.

¹ J. E. R. M'Donagh, *The Biology and Treatment of Venereal Diseases* (Harrison & Sons, London, 1915); *British Journal of Dermatology*, London, 1914, vol. xxvi. p. 233.



Juxtaposed chancres of the labia majora.
(Gougeret "Le traitement de la Syphilis," plate v.)



Chancres of the "Os Uteri," (Mraček Atlas of Syphilis, plate vi.)

- A. On the anterior lip, close to the os, is a slightly raised induration, the floor of which presents a diphtheritic appearance and is marked in places by small haemorrhages. Patient, 22 years of age. Last coitus, 7 weeks previously.
- B. On the anterior lip is a circular, sharply circumscribed ulcer with a purulent floor. Patient, aged 43.

Chancres may be single or multiple,—the latter being much the commoner condition in women—pure or mixed, that is to say, doubly infected (Plate XV.). In such a case it may happen that the pus forming part of the combined poisons apparently predominates, and the induration may be more or less destroyed. A woman may present undoubted signs of syphilis; the labia may be swollen and oozing pus from the inflammatory condition, and no sore discoverable. If the patient be placed under treatment and the septic condition cleared up, the remains of the chancre may be sometimes clearly shown. Should this secondary infection be more marked, the condition may become one of phagedaena. I do not think this latter is so common in women as in men. Or the chancre may be a *relapsing* one. In my experience this is rarely seen in women but is quite common in men.

In February 1907 a case aged 20 was admitted into the hospital with an indurated chancre on the right labium and general syphilis. The throat symptoms were especially persistent. In August following, the chancre relapsed, occupying the original site; its margins were raised, hard and rounded, sloping down to a dry shining indurated base and the glands again became enlarged.

In June 1906 a case aged 26 was admitted with an indurated chancre, etc., and severely ulcerated tonsil. She was most intolerant of mercury. However she was treated with injections of calomel and the condition cleared up. The chancre relapsed six weeks later and again in August of the next year.

In the *Lancet*, May 1896, I¹ showed that in many cases of relapsing chancres the stress of the disease in the early stages will be found to have fallen especially on the mucous membranes, throat, etc., in preference to the skin, and that they may recur many years after the original lesions, and this without any further relapse of the disease.

Sir Jonathan Hutchinson² said: "The knowledge of the facts as to recurring chancres is of very great importance, since without it very serious mistakes may occur, not only as regards treatment but in reference to social and medico-legal questions."

These relapsing chancres may occur quite apart from fresh intercourse, and may be quite uninfluenced by specific treatment. But the case in which the chancre relapses many years later may at times be due to reinfection, as the following shows.

Some sixteen years ago a man attended my out-patients with an attack of syphilis. He attended regularly for four years. Ten years later, having had no symptoms in the interval, he returned with a fresh chancre which occupied the exact site of the original

¹ A. Shillitoe, "Eighteen cases of Indurated Pseudo-chancres," *Lancet*, London, 1896, vol. i. p. 1479.

² Sir J. Hutchinson, *Syphilis*, p. 124 (Cassell & Co. London, 1887).

lesion. This, he said, had appeared one week after intercourse and made him very anxious as he had arranged to get married in six weeks' time. At first I was inclined to regard it as an ordinary case of relapsing chancre, but fortunately decided to examine it microscopically, when *Treponema pallidum* was found to be present in large numbers, and his arrangements for marriage were vetoed.

In women two chancres are frequently seen on the juxtaposed surfaces of the labia majora, and in such a case it will generally be found that an interval of a few days has elapsed between the appearance of the two. The time-limit for such auto-inoculation is thought to be about eleven days. The fourchette is a favourite site for this condition.

Indurative oedema of one or both labia majora is another far from rare form the initial lesion may assume. The thick and leather-like consistence of the labium, so different from the oedema of ordinary inflammation, is almost pathognomonic of syphilis. It is often so extensive as to make the discovery of the original sore impossible. It is often most rebellious to treatment, and not infrequently recurs in later life (Plate XVI.).

Chancres of the vagina are but rarely met with.

Chancres of cervix uteri would probably be more frequently found were they more systematically sought for. It should, however, be remembered that a chancre situated on the cervix clears up more rapidly than one found elsewhere. As a rule it causes no inconvenience and the inguinal glands are seldom involved, the lymphatics draining to the pelvic set. Its surroundings, viz. freedom from irritation, a somewhat elevated temperature, and moist surrounding atmosphere, tend to encourage its early resolution; indeed long before the onset of secondary symptoms might lead to the discovery of the initial lesion, all trace of it may have cleared up.

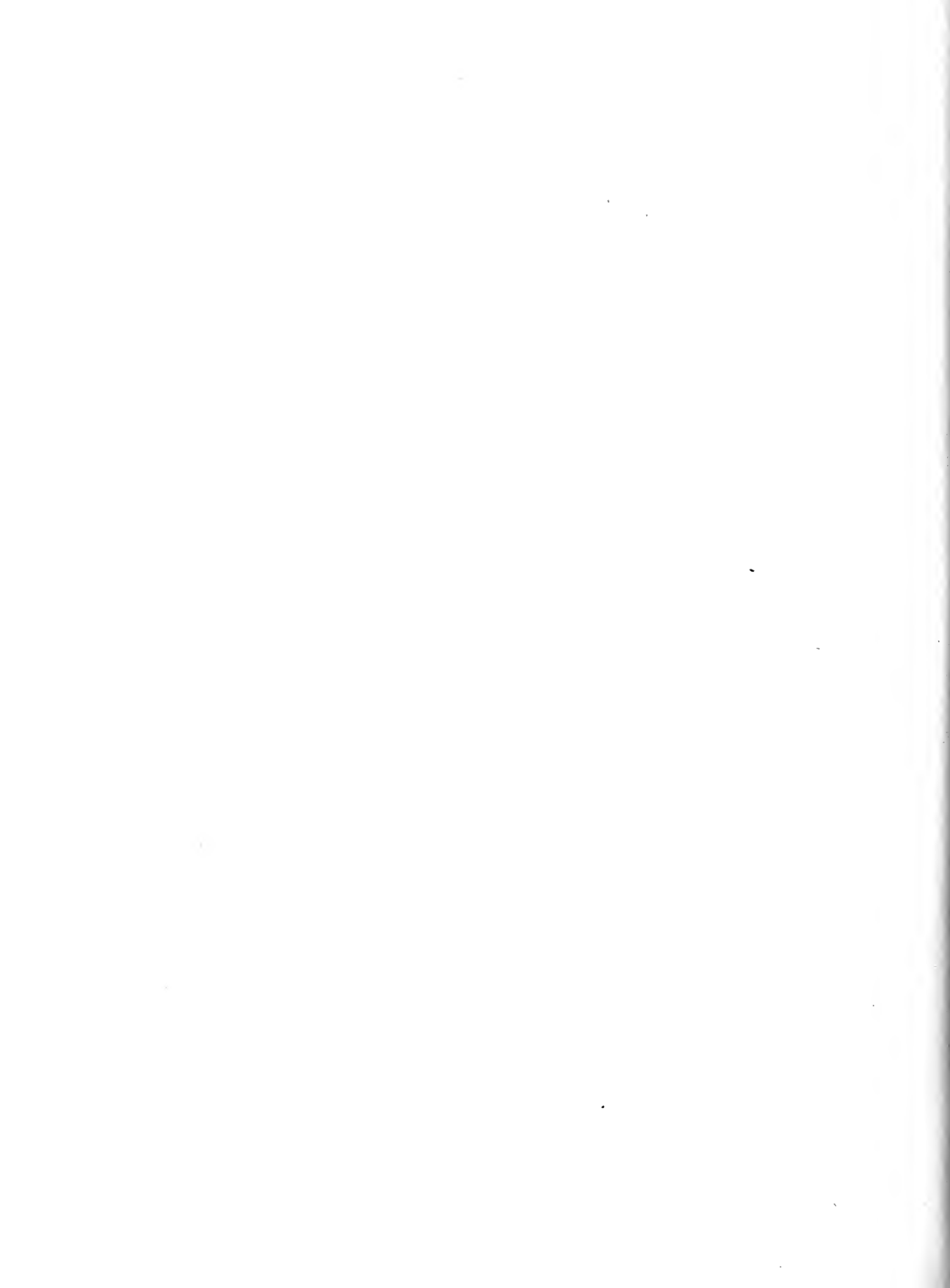
As is to be expected, a sore showing so rapid a resolution will vary in appearance according as it is seen early or late. It may be single or multiple, more often the former, round or oval, smooth and regular, raised, seldom depressed; it has no definite edge, gradually melting away into the surrounding tissue, resembling an enlarged papule (Plate XV.).

Fournier said: "Such a sore almost always shows a waxy-grey colour, seemingly due to a sort of false membrane; later this turns yellowish, and the sore becomes dotted over with ecchymoses. At the end of a few days the change is absolute; it is no longer yellow, no longer a papule, nothing more than a reddened erosion, common, banal, and innocent in appearance."

A chancre of the cervix, unlike chancres elsewhere, bleeds readily. The presence of induration and adenitis are difficult to determine. The induration should never be



Indurative œdema of the left labium majus, (from Mraček "Atlas of Syphilis," plate v,) shewing how greatly the indurative œdema exceeds the size of the chancre here seen. The condition had been present one week, having appeared six weeks after the last coitus in a woman 21 years of age.



sought for by digital palpation, the risk of infection being too great ; it may, however, be detected by means of a long pair of dressing forceps. This is not altogether easy.

The lymphatics, as previously stated, drain into the glands of the pelvis. Occasionally, owing to the free anastomosis of the lymphatics, the inguinal glands may be involved, and Thibierge insists that this point is too often overlooked. So that in a case where the inguinal glands are involved and no vulval sore discoverable, the possibility of a cervical chancre being present should be remembered.

A chancre of the cervix is much more lasting in a pregnant woman, and may seriously interfere with parturition from the rigidity of the os it gives rise to.

A single woman, aged 26, was found to have two large, smooth, dull-red, papule-like sores, one on each lip of the cervix. The inguinal glands were quite typical. The condition had been recognized eighteen weeks before her admission into the hospital and four weeks before her confinement of an eight-months child, who only lived a few days.

A chancre of the cervix may ulcerate, at times rather severely ; the induration may be destroyed or impossible to make out owing to the exquisite pain caused by the manipulation of the forceps, however delicately done, and so, as an aid to diagnosis, Thibierge¹ suggested auto-inoculation of the abdominal wall from the suspicious sore, failure of such an experiment being regarded as strong presumptive evidence of the sore on the cervix being a specific one.

Differential Diagnosis.—A chancre of the cervix has to be diagnosed from :

1. A *simple 'erosion,'* which is flat or slightly depressed, bright red, not indurated, and generally spreading from inside the os. The cause of the condition, an endocervicitis, may generally be determined. If the surface of the erosion be covered with pus like a pellicle, this may be readily rubbed off, which is not the case with a specific sore.

2. *From epithelioma.* The age of the patient should be taken into consideration, though cases of malignant disease of the cervix do occasionally occur in young women. Is the woman a nullipara ? Less than 4 per cent of cases of epithelioma occur in the absolutely sterile. If the body-wasting be great, if haemorrhage occur at times other than at the periods, or if the discharge from the sore be extremely offensive, then malignant disease may be suspected.

Extragenital Chancres.—Chancre of the anus and chancre of the upper and inner part of the thigh are occasionally met with. These may be due to an accidental

¹ G. Thibierge, " Sur le chancre syphilitique du col l'utérus, et en particulier sur une forme ulcéreuse ; sa confusion possible avec l'épithélioma utérine," *Annales de Dermatologie et de Syphiligraphie* 1904, 4^{me} sér. vol. v. p. 113, Paris.

inoculation at the time of coitus, but are more frequently brought about by perversion of the sexual act, either from the dread of pregnancy or the old superstition that syphilis can only be acquired by intercourse. An anal chancre may be insignificant and give rise to no discomfort, but I have seen most extensive ulceration occur therefrom. The glands involved in such a case are those at the extreme outer part of the inguinal chain. Extragenital chancres in women, save that they are more frequently met with than in men, do not call for any particular comment.

THE STAGES OF THE DISEASE

Primary Stage.—The primary stage of syphilis may be thus divided: (1) an incubation period, (2) induration of the chancre, (3) implication of the corresponding set of lymphatic glands.

The *incubation period*, that is to say, the time that elapses from the date of infection to the appearance of the chancre, is very difficult to estimate. As we have already stated, history is generally quite unreliable, but the time is generally thought to be from twelve days to six weeks. Sir Alfred Cooper¹ said: "If the infection be derived from a primary sore, the incubation period would be found to be shorter than when derived from some secondary lesion." This is probably correct, the *Treponema pallidum* possessing a greater virulency in the earlier than in their later generations.

In women more frequently than in men there is found quite early an outbreak of condylomata and papules on the parts immediately adjacent to the chancre, that is to say, the labia majora, anus, and upper and inner parts of the thighs. But in parts farther away the succeeding eruptions may only show themselves as roseolae or scattered papules. These condylomata have long been recognized as perhaps next to the chancre, the most contagious of all syphilitic lesions, and the frequency with which they occur in all types of women requires some further explanation than that usually advanced, viz. that they owe their origin to the natural moisture and heat of the parts. The virulency of the poison often seems to be greatest in the neighbourhood of the initial lesion.

In the attempts that have been made to estimate the incubation period by experimental inoculation of animals, the most virulent agents, a chancre or condyloma, have generally been used. A syphilitic man with no sore on his genitals may only infect the woman indirectly through the foetus she has conceived by him (see Conceptional Syphilis).

¹ Sir A. Cooper, *Syphilis*, 2nd edition, by E. Cotterell, p. 92 (J. & A. Churchill, London, 1895).

There is one point worthy of special mention, however, viz. the importance of always examining the tongue. If, in the case of a woman with numerous condylomata and papules on and about the genitals, you look at the tongue you will very frequently find a papilloma situated in the angle formed by the circumvallate papillae, that is to say on that part of the tongue which is not exposed to pressure. Among hospital female patients with gonorrhoea one occasionally meets with cases of papillomata or gonorrheal warts, so extensive as completely to cover the parts from the umbilicus to the anus, but the tongue in these cases will not be involved.

The *induration* has been shown to be due to the formation of the granuloma by the action of the specific organism on the connective-tissue cells, and there is no great call on the leucocytes and no phagocytosis. At the end of three or four weeks the chancre generally cicatrizes and the induration disappears. It may leave a scar, at first pigmented, later becoming white, or more frequently perhaps it clears up completely, showing no evidence of its past existence. The late Berkeley Hill used to teach that years afterwards, when all signs had long disappeared, he could by examination of the site of the primary lesion often say positively that a patient had had syphilis. On making tense the skin over the site of the original sore, a peculiar blanching is noticed if the case were originally a syphilitic one.

The amount of induration is no guide to the severity of the after-coming symptoms, but persistence of the induration in spite of treatment indicates a probably severe attack. I can recall cases in which the induration has persisted and was followed by early and severe tertiary lesions. The reason why a specific sore on resolution seldom leaves any deformity is that the induration, which consists mainly of plasma-cells that have no proteolytic action, is absorbed. No polymorphonuclear leucocytes being present there is little or no destruction of tissue.

Adenitis.—"The invasion of the anatomically-related lymphatic glands follows the chancre as the shadow the body" (Ricord), and generally begins about one week after the appearance of the chancre, thus completing the primary stage of the disease. In fat women it may be impossible to feel them. In spite of the fact that mixed infection is perhaps commoner in women than in men, buboes are seldom met with. A pure syphilitic adenitis is, as the French say, *à froid*, and not complicated by a periadenitis which is characteristic of septic absorption.

Secondary Stage.—The stage of secondary eruptions is preceded by a second period of incubation, which will generally be found to be an interval of from three to six weeks from the time of appearance of the chancre.

In women when looking for secondary symptoms one should never omit to examine the back. This is a particularly favourite seat for an eruption, and over

and over again one sees a case with little or no evidence of an eruption on the front of the chest and abdomen, while it may be profuse on the back. This is an important but too often neglected point, either from disinclination on the part of the patient to remove her dress, or from the old idea that specific eruptions are only found on the anterior and flexor surfaces of the body. Anatomically it is interesting to remember that the superficial layers of the muscles of the back, viz. trapezius and latissimus dorsi, the rhomboidei and the serrati, are dorsal extensions derived from the *ventral* muscle of the somatopleure.

With perhaps one exception the eruptions of secondary syphilis in women do not differ from those seen in men. They, especially the roseolae, may be more evanescent or fugitive, and in the case where one sees a faint roseola on the extremities it may often be made more evident by congesting the part by means of an elastic band placed round the limb, near the trunk.

But the one exception is the presence of *leucoderma cervicis*; this is almost peculiar to women and is very seldom seen in men. It is perhaps more than any other eruption pathognomonic of syphilis. Alfred Fournier said that in his long experience he could only recall two cases of this condition which he was unable to satisfy himself were syphilitic. Among hospital patients this is one of the commonest conditions found in early syphilis in women. In D'Arcy Power and Keogh Murphy's *System of Syphilis*, 1908,¹ I showed that out of 50 consecutive cases of syphilis in women it was demonstrable in 37; 9 of the cases were so early as only to show the chancre and adenitis. The majority of cases were between seventeen and thirty years of age. The symptom when well marked may be a source of great worry to women, and is, to those who know, particularly incriminating. It may clear up in a few months, or endure for a lengthy period, and it is not greatly influenced by treatment, either by mercury or salvarsan. There are no subjective symptoms, and since it rather affects the back of the neck it may escape notice in an unobservant woman; though occasionally a patient will tell one, that her friends have recently remarked on her dirty neck.

It is said never to occur in congenital syphilis, but the following case shows that it may occur in a congenital syphilitic with acquired syphilis.

A girl, single, aged 20, with well-marked signs of old keratitis, the bridge of the nose broad and depressed, and the soft palate destroyed and cicatrized, was admitted into the hospital with multiple sores on the labia majora, general typical adenitis, a fading macular

¹ A. Shillitoe, "The Primary Lesions and early Secondary Symptoms as seen in the Female," see *System of Syphilis*, edited by D'A. Power and J. K. Murphy, vol. i. p. 225 (Frowde, Hodder & Stoughton, London, 1908).



Leucoderma cervicis. (Alfred Brandisciner.)

Shewing the achromic areas occupying the site of the antecedent eruption, surrounded by a pigmented network. The remains of the papules are seen in the centre of several of the white areas; in others they have cleared up completely.

eruption on the thighs, back, and abdomen, with a *condyloma latum* at the umbilicus, and sore and spongy gums. The roseola extended up into the neck. She had one child healthy, aged one and a half years. She had had already two months' treatment, and ten days after admission developed a pigmentary syphilide of the neck.

The seat of election for this condition is the nuchal triangle, whence it spreads laterally round the neck, forming the aptly-called "collar of Venus." It may spread generally over the trunk, but as a rule avoids the genital region. The condition is found in two forms :

1. A well-marked broad band of pigmentation extending round the neck.
 2. As achromic patches or white islets in a pigmentary network (Plate XVII.).
- The first may be, but not invariably, the preliminary stage of the second.

The deposited substance is not blood pigment, but melanin, which is manufactured by the epithelial cells in the basal layers of the epidermis.

The questions raised about this common but most interesting condition are :

1. Does the pigmentary network surround islets of normal skin ?
2. Do the white islets present a degeneration of pigment ?
3. Does the pigmentation appear from the first as such, and are the white islets found later in this tissue ?
4. Is the deposition in a network primary ?
5. Does the pigmentation appear *de novo* as such ?
6. Is it preceded by an exanthema ?

It is now generally recognized that the achromic spots are the remains of a roseola or other secondary syphilide, preserving the site, form, and dimensions of the lesions which have given birth to them. That this is so in many cases one can easily satisfy oneself. Take a case with a marked roseolar or papular eruption on the neck and then apply a strip 3 × 6 inches of clear gelatine to the back of the neck, mark with a pen the spinous processes, in order to get the mid line ; next ink in the macules or papules as seen through the gelatine strip, initial and date the chart. Under treatment the eruption will clear up and will be succeeded by a deposit of a more or less marked network of pigmentation with achromic areas. When the process has reached this stage re-apply the gelatine chart. The markings of the spinous processes will fix the central line of the neck, and the achromic areas will be found to occupy the site, form, and dimensions of the macules or papules which have given birth to them. The macules and papules clear from the periphery to the centre, and the last trace of this clearing up may often be seen in a small pigmented spot in the centre of the achromic area. The roseolae in the region of the neck are, especially in women, often most evanescent, and are therefore not infrequently missed.

In 1893, André Broca suggested the use of cobalt-blue glass, claiming that, (1) it made an eruption visible before it could be seen by the naked eye; (2) it showed up traces of an antecedent eruption; (3) it made a faint eruption more evident. In using it dull daylight is preferable to bright sunshine or artificial light; the part to be examined should not be on the stretch but inclined slightly towards the observer, the examination should be made obliquely from the side and not directly in front. The cobalt-blue glass should be placed as close to the examining eye as possible in order to avoid diffusion of the rays. This may be accomplished by using spectacles with dark side-pieces.

Jullien¹ of the St. Lazare Hospital, Paris, said that, "By thus isolating the eye, the epidermis appears of a uniform blue colour, but if in the thickness of the integument there be red congestive areas impossible to distinguish in the surrounding white light the red congestive cutaneous colour will appear because it is complementary to the cobalt blue, and clinically we get either (1) the picture of an eruption before the unaided eye perceives it, or else (2) the evidence of an obliterated eruption." And so we may almost say that, "Thanks to the 'verre bleu, il n'y a plus d'éruption fruste.'"

TREATMENT

The treatment of syphilis must be individual; and by this I mean no hard and fast rules for dealing with any one case can be laid down. No two individuals will react alike either to the poison or to the antidote. The two factors in question, viz. the individual and the disease, must be both singly and conjointly considered, and failure to deal with either of them will jeopardize the result, and may end in disaster. The final effects of the attack will be found to vary with the powers of resistance the patient is capable of exerting.

One of the greatest difficulties met with in dealing with these cases is that they are so often cases not only of *syphilis insontium*, but syphilis of the ignorant; and over and over again, for the sake of family peace, and perhaps for the sake of the patient herself, we, as medical advisers, are obliged to maintain this state of innocence and ignorance during, it may be, a very long course of treatment. But in the last few years the new methods of treatment and of diagnosis have done much to educate, by the publicity given to them in the daily press, both women and men. Much still remains to be accomplished before secrecy, that bane to proper treatment in women, can be consigned to the limbo of the past.

¹ L. Jullien, "Le verre bleu en syphiligraphie," *Annales de Dermatologie et de Syphiligraphie*, 1899, 3^{me} sér. vol. x. p. 69.

Before condemning any one to a prolonged course of treatment it is necessary to make sure that she has syphilis, and the earlier the diagnosis can be determined, the sooner treatment be started, the better the prognosis. A woman has a suspicious sore, the glands perhaps not yet implicated. The disease is not yet generalized, and, therefore, a Wassermann blood test or a Noguchi cuti-reaction are useless. The finding of the *Treponema pallidum* makes the diagnosis certain, and treatment may be immediately started. In order to accomplish this, wash away the *débris* from the surface of the sore with saline, then squeeze the sore to express serum from it, or make a scraping, without causing bleeding. Place a platinum loop-hole full of the secretion on to a clean slide. On one side of this place a drop of water, and on the other a drop of an emulsion of indian ink. Mix the three drops and make a film with a cover-slip in the same way as a blood film is made. The specimen is allowed to dry and then examined with an oil-immersion lens, when it will be found that the organisms stand out white against a black background.

Provided that there be no contra-indication, such a case is especially suitable for treatment by salvarsan, and in order to determine what conditions constitute contra-indications, it is necessary to consider the effects produced by the drug on the patient.

The first effect of giving an intravenous injection of salvarsan is to cause a rise in the blood pressure; this is followed by a corresponding, or greater fall, so that it is advisable to keep the patient perfectly still in bed for some five or six hours after the injection. Some time ago I had occasion to give a patient an intravenous injection. Apart from the syphilis he was a strong healthy man. He took the injection well and followed my instructions as regards absolutely resting. Ten days later I repeated the injection and instructions, which he laughed at, saying I was over cautious but promising none the less to observe them. Ten minutes after my departure from the house he got up and fell unconscious across the bed. On recovering consciousness he managed to crawl back into bed again. He recovered and did well, but as I told him, had he died, the salvarsan and myself would have been most unjustifiably blamed.

Arsenic exerts a toxic effect upon the walls of the arterioles and capillaries, and may give rise to haemorrhage or oozing. Cases are on record which have received an injection soon after an operation, and the dressings have been found more or less soaked with blood. The same holds good with diseased tissues, *e.g.* the heart, which should be always carefully examined, and if evidence of endocarditis, etc., be found the use of salvarsan is generally contra-indicated. Salvarsan should not be used where there is reason to suspect disease of the blood-vessels, intracranial or

otherwise. It should never be used in cases of aneurysm or in cases of phthisis where there is cavitation, when a fatal haemoptysis might result. It should not be employed when the viscera, by which the drug is chiefly eliminated, are diseased, e.g. the liver and kidneys. Diabetes and epilepsy are contra-indications, and so are disease of the internal and middle ear, and commencing optic atrophy.

These are perhaps the chief contra-indications, from which it may be seen that the use of salvarsan is not free from danger. The condition of pregnancy is often no bar to the employment of the drug, and in many a case both the mother and her offspring have been saved by its use. It should be remembered that the original preparations of salvarsan and neo-salvarsan are no longer obtainable, and that the efficacy of the present substitutes for these have still to be proved.

Every patient should be carefully examined before submitting to a course of salvarsan. If the case be suitable she requires preparing in the same way as for any other operation. Salvarsan requires a very careful technique for its administration, and should only be used by those conversant with this. Further, it is now generally agreed that salvarsan alone cannot be relied upon to effect a cure.

Mercury, which had been used in Asia and America ages prior to the introduction of syphilis into Europe, still is our chief if not only means of effecting a cure. It has been said that mercury is to syphilis what water is to fire, in the hands of a physician who knows how to use the drug rightly, how to apply it at the right time and in the right form. A course of mercury may be given continuously or intermittently. Personally, I prefer the former or continuous method, and for the following reasons.

One of the most important questions of the present day in regard to the disease is the marked increase in the number of cases of general paralysis and tabes, and this in spite of the so-called improved methods of treatment. Douglas White¹ said: "In the past decade there has been an increase in the number of deaths from aneurysm, tabes, and general paralysis. From aneurysm more than 1000 die annually, from tabes about 600, and from general paralysis of the insane 2400." In 1905 Dr. Thamsen² of Copenhagen informed me "that twenty years ago syphilis in Denmark was of the malignant ulcerative type. To-day they use the intermittent treatment. Mental and nervous diseases are both relatively and absolutely on the increase. Denmark has of late years been obliged to very considerably increase her accommodation for lunatics. Alcoholism is decreasing, there

¹ J. Douglas White, "Social Aspect of Syphilis," *Proceedings of the Royal Society of Medicine*, 1912, vol. v. (Suppl. Discussion on Syphilis), p. 143.

² A. Shillitoe, "Syphilis in relation to Life Assurance," *Transactions of Life Assurance Medical Officers Association*, 1904-5, p. 233, London, 1906.

being a constantly increasing tendency to abstinence." Fournier insisted that the chief cause of general paralysis was inefficient treatment in the early stages—out of 79 cases 63 had been treated for one year and under. In 1904 Clouston¹ reports 49 cases of general paralysis, the peculiarity in this year being the number of women afflicted. They amounted to 22, or 8 per cent, of the total admissions. Of 123 deaths this year 16, or 23 per cent, were women general paralytics. From 1874 to 1883 there were only 7·5 per cent deaths among women from this complaint; 1884 to 1893, 9·7 per cent; 1894 to 1903, 12 per cent; and this year, 1904, 23 per cent. In 1898 Dr. Heron said, "We know from official statistics that in this country insanity is not increasing while general paralysis is," and I believe the statistics of other countries would show the same melancholy results, due, I think, to inefficient treatment, and in this I include the interrupted treatment.

Whether or no the above opinions are correct, the fact remains and cannot be denied that the number of cases of nerve lesions is and has been steadily increasing in the last thirty or forty years; that is to say, since we began to give up the continuous method of treatment of our fathers. Undoubtedly in many cases secondary lesions may be made to disappear more quickly by a course of intramuscular injections than by the older method, but if the cost of this is the appearance of serious nerve lesions in later life, is it worth while?

Mercury may be administered in many ways, by the mouth, per rectum, by the skin, intramuscularly, etc., and the preparations used are numerous; one method will suit one case but not another. It is the patient's peculiarities and idiosyncrasies that must be studied.

Not infrequently a patient requires very careful treatment before starting mercury, or it may be that she is suffering from the double poison of syphilis and mercury which had been injudiciously administered. Such a case I have recently had under my charge. Her head and neck were covered with rupia; on the trunk were numerous rupial and ecchymatous patches; she was in a very low cachectic condition. We started her on a course of sulphur-fumigation baths, and in a few days the improvement both locally and in her general health was most remarkable. This is really a very old but now seldom used method of treatment, perhaps because we do not in the present day see so frequently as formerly the severe cases of cachexia, either syphilitic or mercurial. As long ago as 1838 Jonathan Green wrote: "When the system has been largely dosed with mercury and the general health has given way, without the syphilitic symptoms appearing to have yielded, a 'sulphur fume bath,' $\bar{5}$ i to $\bar{5}$ iii, will be found most useful." Patients may be so

¹ J. S. Clouston, *Annual Report of the Royal Edinburgh Asylum*, 92nd, 1905, p. 18, Morningside, 1906.

weakened by the poison that it may be necessary to carry them to the bath. The rapid recovery is remarkable. The sulphur seems to act as a wholesome stimulus to the system.

In certain badly ulcerated throat conditions in which salvarsan is not used, considerable improvement is often brought about by a mixture of perchloride of mercury and iodides. I always use the sodium and ammonium salts in preference to the potassium iodide, and when under such a course the patient should be instructed to sip a large tumbler of very hot water one hour before each meal as this helps to prevent the unpleasant effects of the iodides.

In cases of chancre of the cervix or in cases of pregnancy, Riehl of Vienna suggested the daily application to the cervix of 3 grammes of the following ointment : lanoline and lard equal parts, and 12 to 15 per cent of mercury. The ointment is kept in position by a carefully applied tampon, made impermeable by impregnating it with a mixture of two parts glycerine and one part tannin. Thirty-six out of forty pregnant women reached term.

Many of the cases of tertiary syphilis are due to neglect or inefficient treatment in the early stages, and so we find that a case with slight secondary symptoms is often the most serious on account of the probability, especially in women, of treatment being neglected. Many cases seen in later life will be found to have been treated with iodide of potassium alone and no mercury. This is of course a much-to-be regretted method ; it gets rid perhaps of the symptoms quicker but does not cure the disease. The only drug for this purpose is mercury.

Every care should be taken to keep the patient in as perfect a state of health as possible, with fresh air and gentle exercise, always stopping short of fatigue. The teeth should be kept scrupulously clean, and where pyorrhoea is present this should be cleared up as rapidly as possible. A fortnightly record of the weight should be kept. If this be found to be falling, a change of treatment is called for. The increase or fall in weight is useful in determining the dosage of mercury. Many women in the present day are cigarette smokers. The use of tobacco and alcohol should be forbidden.

Synopsis.—The patient should be kept in as perfect a state of health as possible ; under no circumstances should she be encouraged to regard herself as an invalid. Everything should be done to increase her powers of resistance to the poison.

Having made sure of your diagnosis, start treatment as early as possible.

A correct record of the weight is a most useful guide to the proper dosage of the drug employed.

Salvarsan is not to be depended upon alone to effect a cure, but should be used

in every case, unless contra-indicated, and should be followed by a minimum course of two years of mercury. The course varies with the age of the patient, the older the patient the longer the treatment necessary.

For a continuous course of mercury I find the use of suppositories preferable to pills, being less disturbing to the digestion and less liable to cause salivation. One suppository introduced at bed-time is more convenient than taking pills or mixtures several times a day. I generally start a case with grain $\frac{3}{4}$ of the salicylate of mercury, gradually increasing the strength, if the weight of the patient is going up, to grains iii or iiiv, but only a few will stand this larger dose.

Finally, it must be remembered that no two cases react alike, either to the disease or to the drugs used to combat it.

CONCEPTIONAL SYPHILIS

By this is understood the infection of a mother with syphilis, not directly, but indirectly, through her foetus, which she has conceived of a syphilitic father.

Besnier said that every woman who has conceived by a syphilitic man is or may be syphilized. Such cases are said to be characterized by the complete absence of the primary stage of the disease, and consequently are to be regarded as attacks of syphilis with a true *début d'emblée*. The outbreak of a secondary eruption may be the first indication that the mother is infected; or, as frequently happens, the secondary lesions have been absent, or so slight as to have escaped all notice, and it is only some years later that the outbreak of some more or less severe but positive tertiary lesion shows what a false state of security the often innocent woman has been living in; her trouble really dating back to perhaps the only occasion on which she had been *enceinte*, the pregnancy having terminated in an abortion, still-birth, or a living, but syphilitic, child. So we see that evidences of conceptional syphilis may be found either early or late in life.

Fournier said that tertiary syphilis is one of the most common conditions he had to treat in elderly married women. His statistics show that out of 100 cases of syphilis in women 20 were married, and that 70 per cent had acquired syphilis from their husbands, who had been infected before marriage. That of 130 women, who had acquired the disease during the first year of married life, 117 were infected within the first six months by husbands who had contracted the disease within three years of marriage. It has been estimated that 20 per cent of syphilitic women acquire the disease under the age of twenty and the majority of men probably acquire it under thirty; so that syphilis may be looked upon as a disease of inexperienced youth.

I do not infer that all these cases, or anything like all, were cases of conceptional syphilis. I know of no statistics showing the percentage of conceptional to acquired syphilis. They are only given to show how necessary it is to exercise the greatest caution in giving permission to a syphilitic man to marry. Syphilis in women is very often *syphilis insontium*, and the majority of such cases, whether conceptional or acquired, are inefficiently treated.

How insignificant the signs and symptoms of early conceptional syphilis in the mother may be, the following cases, at present under my care at the Lock Hospital, show. Such slight symptoms might have easily escaped detection in times past, and justified our predecessors in concluding that a syphilitic father might have syphilitic children without the mother being infected.

CASE 1. C. D., aged 27 and single, had intercourse last April, the first and only time. Five months later, *i.e.* September 1914, she was delivered of a macerated foetus. She had had no specific treatment, nor to her knowledge any chancre, glandular enlargements, eruption, sore throat, or alopecia. She was admitted early in the year 1915 for a chronic vaginal discharge. The most careful examination failed to discover any evidence of syphilis, with the exception of a faint *leucoderma cervicis*, a condition, in my opinion, pathognomic of syphilis.

Soon after her entry into the hospital the Wassermann reaction was returned as positive. But seeing that the only symptom suggestive of syphilis was the presence of a very faint leucoderma, treatment was withheld for one month, during which time the leucoderma did not increase in intensity, neither did any other symptom appear.

The Wassermann test was now repeated and again returned as positive. Energetic treatment was then started with the view of, if possible, curing the disease and so preventing its reappearance later in life.

In such a case the very slight signs of the disease, the leucoderma, might have been easily overlooked. The patient had received no treatment for the ten months from inoculation (April to February), she was ignorant of the poison she carried, and had it not been for the fortunate accident of a vaginal discharge, which obliged her to seek advice, she might have been troubled years later with a more or less severe tertiary accident. This we hope we have prevented.

CASE 2. M. M., aged 21 and single, had one child born in the eighth month two years ago. Shortly after birth the baby developed 'snuffles' and was treated with inunctions of mercury. There has been no further pregnancy, and no symptoms, and she has had no treatment. She was admitted early in March 1915 with gonorrhoea; no evidence of syphilis was discoverable, but the Wassermann reaction was positive, and she is under treatment.

CASE 3. L. S., aged 25, married, had one miscarriage at the sixth month three years ago. Admitted into the hospital in September 1914 with her child born at the end of July, at full term. The baby was apparently healthy when born, remaining so for one month, when it developed a general eruption and two weeks later 'snuffles.'

On admission the mother showed no signs of the disease and had received no treatment. Her husband is a syphilitic. Both mother and child gave positive Wassermanns, and both are under treatment.

Many syphilis-infected men have been allowed, and rightly allowed, by their doctors to marry; their wives have not suffered, neither have their children been contaminated; this shows that they have been efficiently treated. But should a man marry too early after infection he runs the risk of infecting his wife in one of two ways: (a) directly, (b) indirectly through the ovum he has specifically tainted, *i.e. conceptional syphilis*. A man with syphilis may marry, and his wife may escape infection so long as she does not become pregnant.

In many cases of conceptional syphilis it has been proved that at the time of conception the father was, and had been for many months, entirely free from any symptom of the disease, and therefore probably not in a condition to infect his wife directly. The question as to whether a father can transmit to his offspring hereditary syphilis without infecting the mother has been fought over and over again even up to quite recent times. Prince. Morrow¹ says: "Experimental inoculations have shown that the sperm of syphilitics is not susceptible of inoculation. A woman may be inundated with the sperm of a syphilitic and remain healthy; but if one of her ovules be fecundated by this same sperm . . . there is engendered a syphilitic being, which, through the agency of its foetal blood, will contaminate the mother." In *Syphilis*, 1909, the late Sir Jonathan Hutchinson² said: "The evidence on this point seems to me overwhelming. It is a matter of constant experience that a father of a syphilitic infant is known to have had the disease before marriage, while not a symptom has ever been observed in his wife."

These comparatively recent observations must to-day be regarded as obsolete and of merely historical interest in view of recent researches and discoveries in the disease. The campaign against syphilis has been carried on with varying success since the time of the great epidemic that ravaged Europe after the return of Columbus from the West Indies. But it is only within the last few years that great advances have been made. Without detracting in the least from the careful and continuous work carried on by so many (especially since the duality of syphilis and gonorrhoea was established by Ricord), and which work, indeed, has led up to these great advances, we may claim to-day that the successes of Roux and Metchnikoff in the inoculation of animals with syphilis, the discovery of the *Spirochaeta pallida* (*Treponema pallidum*) by Schaudinn, the serum diagnosis or Wassermann reaction,

¹ Prince. A. Morrow, *Social Diseases and Marriage*, p. 193 (Appleton, London, 1904).

² Sir J. Hutchinson, *Syphilis*, new edit., p. 412, London, 1909.

and the advances made in the method of administering arsenic by Ehrlich, have brought about a considerable revolution in our former views on syphilis. These discoveries have still to be perfected, but the arguments to be deduced from them, if properly applied to the question of conceptional syphilis, should go far towards proving that a father *cannot* infect his offspring with hereditary syphilis without infecting the mother.

M'Donagh¹ has kindly allowed me to make use of the following cases to illustrate the effects of conceptional syphilis later in life.

CASE 4. Mrs. B., aged 46, attended the hospital with a gumma of the right arm and gummatous scars on the right leg. These had appeared in the autumn of 1909. She had married at the age of 21, and had never experienced the slightest evidence of syphilis before the above-mentioned date. She had had 4 miscarriages; 11 children were born, 2 of whom were still living—the results of the second and fourth pregnancies. All the other children had died within six months, as the result of syphilis. Her last pregnancy was a miscarriage, immediately after which she developed a bad leg; this pregnancy was followed by the change of life.

She gave a strong positive Wassermann. The second pregnancy, a son, has given a negative Wassermann, as have his wife and child. The fourth pregnancy, a daughter, has also given a negative Wassermann. Neither child has shown the least taint of disease.

CASE 5. Age 47, attended the hospital with gummata of the right leg; these, as in the previous case, had only appeared after the change of life. Patient had been pregnant nine times; the children had mostly been premature; some had been born alive, others dead; not one had lived more than a few weeks.

He says he has since seen many such cases who gave a positive Wassermann reaction, provided that the child-bearing period was over, but that it is not uncommon to find that a woman, while still giving birth to syphilitic children, will give a negative Wassermann until after the climacteric is reached.

M'Donagh accordingly formulated the following rule:

“If a woman contracts syphilis after she has conceived, the Wassermann's reaction will be positive, because the disease becomes generalized and behaves in the ordinary way; but should a woman contract syphilis at the time of conception, the Wassermann reaction may be negative, because the disease, even if it does become generalized then, does not give rise to symptoms until some later date.” By “later date” I understand either the onset of tertiary accidents after the change of life shall have occurred, or after the termination of the pregnancy. For a woman pregnant with a syphilitic foetus may only give a positive Wassermann after delivery, and only at this time it may be that the disease becomes generalized.

¹ J. E. R. M'Donagh, *The Biology and Treatment of Venereal Diseases*, p. 248 (Harrison & Sons, London, 1915).

In order to make it quite clear what is to be understood by a case of conceptional syphilis, the following description of a typical case by Fournier may be quoted :

“Father syphilitic. Mother healthy. Children die young; then fifteen or twenty years later a tertiary lesion appears in the mother.”

Taking this scheme as a model Leon Perrin¹ gives details of the actors in 32 of these tragedies.

1. In the 21 cases out of the 32 in which the pre-marital syphilitic histories of the fathers are given, 7 had had syphilis previous to marriage, time not given; 1 case was infected two years before marriage; 4 cases were infected three years before marriage; 6 cases were infected four years before marriage; 1 case was infected five years before marriage; 1 case was infected ten years before marriage; 1 case was infected twelve years before marriage.

It should be remembered that in Leon Perrin's cases 10, if not more, of the husbands had been infected from three to four years before marriage. We are not told what amount of treatment the 32 husbands had received, but judging from the final effects in all, save 10, in whom no tertiaries had developed, the treatment was probably not very efficient.

2. *The After-Effects on the Syphilitic Fathers.*—Three developed tabes; 4 developed general paralysis of the insane; 6 had cerebral lesions; 2 had glossitis and leukoplakia; 1 had popliteal aneurysm; 1 had sarcocele; 2 had gummata; 3 died between 28 and 32, no cause given. In only 10 were there no tertiary manifestations.

In the 26 cases of conceptional syphilis described by Diday 10 of the husbands had no lesions; in 6 there is no mention of any; 3 had palmar and other lesions which Diday thought were non-contagious.

To return to Leon Perrin's cases :

3. *The After-Effects on the Mothers.*—The lesions were always severe, often very severe, and the time of their appearance varied from the fourth to the twenty-fifth year. Among them were 3 cases of tabes, 3 of ocular lesions, 4 lesions of palate and nasal bones, 4 cases of cerebral lesions, 3 lesions of the tongue, 7 tertiary lesions of the face, and 9 tertiary lesions of the trunk and limbs.

In the early stages of conceptional syphilis, so far as the mothers are concerned, the disease is of a peculiarly benign type. In Diday's 26 cases the most careful examination failed to discover the existence or trace of any initial lesion. In 17 of

¹ L. Perrin, “Syphilis conceptionnelle à manifestations tardives,” *Annales de Dermatologie et de Syphiligraphie*, 1904, 4^{me} sér. vol. v. p. 1077, Paris.

the cases the early eruptions appeared on the trunk far removed from the buccal cavity and the region of the genitalia.

In ordinary acquired syphilis, especially in women, it often occurs that the earliest appearance of a papular eruption is in the neighbourhood of the genitalia, and the inner aspects of the thighs are a common site for the first outbreak of roseola.

The cases I have quoted show that secondary lesions in cases of conceptional syphilis may be so slight, so insignificant, as readily to escape notice.

The Effect on the Product of Conceptional Syphilis.—If the effect on the mother is, as we have seen, benign, the effect on the offspring is most malignant.

The pregnancy more often than not ends in abortion.

Case 1. I have quoted, aborted at the fifth month.

Case 2. Premature birth at the eighth month; the child later developed 'snuffles.'

Case 3. Miscarriage three years ago at the sixth month; a child born seven weeks before admission to the hospital; healthy for one month, when it developed general eruption and 'snuffles.'

M'Donagh's cases:

Case 4. Four miscarriages, eleven pregnancies, all, with the exception of two (the second and fourth), died within six months.

Case 5. Nine pregnancies, most of these were premature; none of the children survived more than a few weeks.

In Leon Perrin's 32 cases, out of 117 pregnancies only 19 children survived to reach adolescence, and many of these were syphilitic.

Hochsinger¹ gives 134 women, who showed no signs of syphilis, who had given birth 569 times: 253 still-born; 316 born alive, and of these only 53 were without taint; 263 being syphilitic, 55 of them dying before the fourth year.

I have endeavoured so far, to show the ravaging effects of conceptional syphilis, and would once more call attention to the facts that (1) such cases are frequently cases of *syphilis insontium*, (2) that the majority of cases of syphilis in women, conceptional or acquired, are inefficiently treated.

The questions next to be considered are: (α) How is conceptional syphilis to be prevented? (β) How can the condition be recognized? (γ) How is it to be dealt with? (δ) What is the *rationale* of the condition?

(α) In the case under consideration the mother is inoculated through the

¹ K. Hochsinger, "Die gesundheitlichen Lebensschicksale erbsyphilitischer Kinder," *Wiener klinische Wochenschrift*, Wien, 1910, Bd. xxiii. S. 881, 932.

medium of the ovum, which at the time of conception had been specifically infected by the semen of a syphilitic father, what Ricord called *choc en retour*.

Therefore, to every man who has had syphilis and is contemplating matrimony, there should be pointed out the dangers his wife may incur from this one fact, that he has previously had syphilis, and that he may be a source of danger to his wife either in the ordinary way as a husband or as the father of their child. So that every care should be taken not only to make the cure complete, but to prove it complete before countenancing marriage. To-day we have in the Wassermann blood-reaction the best way of deciding that a man is fit for marriage.

But it should be noted that there are certain fallacies connected with the test, such as, *e.g.*, a single negative Wassermann is of little or no value; the test should be repeated several times at six months or longer intervals, during which time the patient should not be under treatment. How necessary this may be the following case shows.

A private patient of mine, aged 25, acquired syphilis and was under treatment for three years, at the end of which time, having been free from symptoms for many months, I told him to leave off treatment. At the end of twelve months the blood-test was negative. Another twelve months passed and the result was again negative. Eight months later he married. Within three months he called to see me in a great state of mental anxiety: his wife was about two months advanced in pregnancy and he had recently developed a syphilitic eruption on the glans penis. His blood-test showed strongly positive. The wife's blood-test was negative. This latter was not conclusive. Many women with syphilis will give a negative reaction during a pregnancy, and a positive after deliverance. McDonagh says that in many cases of conceptional syphilis a positive reaction is not obtainable until such patients shall have passed the climacteric, *i.e.* many years after infection. Both husband and wife were energetically treated with salvarsan, etc., with the result that twelve months after the confinement, the mother, father, and child are apparently all three quite healthy.

Again, it should be remembered that a case of long-standing syphilis, treated and apparently cured many years, may give a positive reaction. This does not imply necessarily that the syphilis is active and capable of infecting another individual, but simply that the case has been in times past a syphilitic.

In former times, prior to the important discoveries of recent years, a man was allowed to marry if he had had a prolonged treatment of two or three years and a probationary period of one year without treatment and without symptoms, making in all three or four years from the time of infection. The French always said that this was too short a time. However, experience showed that, given efficient treatment and a satisfactory probationary period, accidents were few and far between.

Many of the cases in which disappointments were met were doubtless due to the fact that sufficient importance had not been laid on the age at which the disease had been acquired. The later in life a patient acquires syphilis the longer the course of treatment necessary. This was evidently Ricord's opinion when he said: "If you wish to have syphilis acquire it young," implying that there is a better chance of cure for the young than in the case of their elders. By "later in life" I mean the apparent, not necessarily the real, age of the man. Syphilis may be as difficult of elimination in a man who has prematurely aged himself by excesses as in a much older man otherwise healthy.

Various modifications, so-called improvements, have been introduced into the method of demonstrating the Wassermann reaction; some are most unsatisfactory, and in my opinion the original method is the most reliable. If thought advisable the result of the Wassermann reaction may be confirmed in one of two ways:

(a) *Noguchi's Cutaneous or Luetin Test*.—Luetin is an extract from cultured *Treponema pallidum*; 0.07 c.c. of the preparation is injected intradermally, *i.e.* below the epidermis. In twenty-four hours a local erythema occurs which in the next twenty-four hours becomes a papule. If this papule disappears within the next four or five days the result is negative; if on the contrary it persists and increases in size the result is positive. Noguchi distinguishes three reactions: (1) the papular, most commonly found in cases of secondary syphilis; (2) the pustular, peculiar to tertiary and congenital cases; (3) the torpid, which does not appear until a few days after the test has been applied.

(b) By the examination of cerebro-spinal fluid.

I do not propose to describe the *modus operandi* of these tests for determining whether or no a man who has had syphilis is fit to marry without risk to wife or offspring. For these the reader is referred to Noguchi's paper in the *Journal of Exper. Med.*, 1911, to M'Donagh in the *Quarterly Journal of Med.*, January 1915, and other authors. In so protean a disease as syphilis probably no one of these tests is applicable to every case; but the consensus of opinion to-day is that the Wassermann test is the most reliable, but it must be made by a competent observer.

The precautions to be observed against a woman becoming conceptionally infected are therefore: efficient treatment, a probationary period, and a satisfactory response to the test, Wassermann or other, on the part of the husband.

(β) *How can the Condition be recognized?*—This is not possible before the termination of the pregnancy. Syphilis is probably the most general cause of abortion. A series of miscarriages and still-births should always suggest the possibility of conceptional syphilis even though neither parent shows any symptoms.

I do think the majority of husbands, when the question is diplomatically put to them, and when the necessity for determining the cause of repeated miscarriages is explained, will be found to allow that in years past they had had a small sore which perhaps had cleared up under a short course of treatment, and that they had thought nothing further of it. I have seen recently such a case: a man aged 75 came to me with a breaking-down gumma of the left testicle. In answer to my enquiry as to when he had had syphilis, he insisted that he had not had an attack, that his wife, children, and grandchildren were all healthy. I then enquired as to whether he had ever had a sore. He said yes, when a young man of eighteen, that it had cleared up after a few weeks' treatment, and he was sure he had had no further trouble from it. Such a man might honestly be convinced that he had never had syphilis.

One of Leon Perrin's cases strenuously denied that he had ever had syphilis, but two years later he died of general paralysis of the insane.

After termination of the pregnancy, and where there is any doubt, the mother's blood might be examined, though, as we have previously stated, a negative Wassermann is not necessarily to be accepted as evidence either way.

If the mother has been delivered of a full-term still-born child, without any signs of syphilis upon it (and we know a syphilitic child may be born apparently perfectly healthy only to develop signs of the disease a few weeks later), it might be advisable to do an autopsy on the infant to determine the presence or absence of the *Treponema pallidum* in the liver or spleen.

(γ) *When recognized, how is Conceptional Syphilis to be dealt with?*—It is quite possible that a proportion of the cases of so-called conceptional syphilis are really ordinary cases of acquired syphilis in which the chancre or initial lesion has been situated on the os uteri. As we show elsewhere, a chancre in this situation has this peculiarity over chancres in other parts, viz. the rapidity with which it clears up leaving no trace behind. We know that a woman may, or may not, show any signs of syphilis during pregnancy, so that at the time of delivery the most careful examination, if it could be carried out, would fail to disclose any trace of a chancre in this situation.

As regards treatment of these cases it differs in nowise from that of syphilis acquired in the ordinary way. In both, the earlier the condition is recognized and the earlier a course of efficient treatment is instituted, the better the prognosis. As efficient treatment will result in the birth of a healthy child, it is generally considered wiser to treat a woman who has given birth to a syphilitic child throughout the period of each succeeding pregnancy, irrespective of the treatment she has previously undergone.

(δ) *How is the Condition of Conceptional Syphilis brought about?*—The discovery of the *Treponema pallidum* was supposed to have settled this question once and for all. But Carpenter pointed out that the head of the spermatozoon measures $\frac{1}{2500}$ of an inch and the organism $\frac{1}{2500}$. It seems reasonable to argue that the *Treponema pallidum* cannot be the actual infecting cause; a much smaller agent must be found. M'Donagh has recently claimed to have proved that the actual infecting agent is a spore, and that the *Treponema* is only a part, but an essential part, in the life-cycle of the infecting agent. It is only in such a way that the phenomena of infection are to be explained. These spores or granules might readily be carried to the ovule by the spermatozoon, whereas we have seen that the *Treponema pallidum* is too large.

For further details on this interesting and much-disputed point the reader is referred to M'Donagh's writings.

STREPTOTHRIX INFECTIONS, INCLUDING ACTINOMYCOSIS, OF THE PELVIS AND PELVIC VISCERA

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(Sydney)

Introduction.—The term *streptothrix* is a convenient generic name for certain higher forms of bacteria, of which many different varieties or species are known to be pathogenic to man and other animals. For the most part they are indistinguishable from one another under the microscope, and, apart from differences in virulence, their pathogenic effects are practically identical. Distinctions between them do not usually become apparent until cultures have been prepared, and that is often a matter of some difficulty. Only in certain cases do the microbes have the typical radial grouping of a ray-fungus or *actinomyces*. But, since an actinomyces was the first to be recognized, and for many years was the only species known to be pathogenic, the name *actinomycosis* has been somewhat loosely applied to the whole group of infections (*streptotrichoses*) of which it is only a particular instance. The tendency of all recent work, and particularly that of Foulerton,¹ has been to show that streptothrix infections are much more frequently the cause of chronic spreading inflammations and suppurations than was formerly realized, and that a great number of different, though closely allied, organisms are concerned.

Streptothrix infections have important characters in common with tuberculosis, leprosy, and syphilis. In all these conditions the principal lesions are found where the microbes themselves are present, and are probably due to the direct action of their endotoxins on the tissues. Since the microbes multiply and are distributed in separate foci of growth, their pathogenic effects are concentrated at each focus of infection. These effects include an inflammatory process, usually of a sub-acute or chronic type, so that nodular overgrowths of granulation tissue are formed, and the conditions were distinguished by Virchow as the *chronic infective granulomata*.

¹ Foulerton, "Milroy Lectures," *Lancet*, 1910.

The microbial endotoxins may modify the inflammatory reaction in such a way as to develop in the granulation tissue peculiar cell forms of which the giant-cell is the most remarkable. In streptothrix infections, however, the giant-cells are, as a rule, less numerous and less definite than in tuberculosis. Other effects also are caused by the endotoxins. In tuberculosis, for example, focal necrosis (caseation) of the inflammatory products is induced; in streptothrix infections a chronic focal supuration is invariably superadded.

GENERAL CHARACTERS OF THE PATHOGENIC STREPTOTHRICEAE, AND OF
THE INFECTIONS CAUSED BY THEM

A. The Organisms.—The main distinctions between the streptothriceae and lower forms of bacteria are (*a*) that the typical structure of a streptothrix is that of a continuous filament, or mycelium, which shows true branching, and (*b*) that reproduction of a streptothrix takes place by the development of gonidia, or spores, from specialized hyphae. There appears, however, to be a definite biological relationship between the streptothriceae and the group of tubercle bacilli; for some varieties of streptothrix infecting man are known to be acid-fast, and tubercle bacilli in certain phases of growth are found to assume the streptothrix form of branching filaments.

Both in the tissues and in cultures, the early stages of the parasite are represented by delicate branching filaments which interlace as they grow, and thus form separate colonies. As they become older, the masses of mycelium become larger, and more and more densely felted and compacted. As age further advances, the micro-organism tends to undergo degeneration, or involution, which may take the form of (*a*) swellings at the ends of the filaments, (*b*) necrotic changes in the centre of the colony, or (*c*) fragmentation of the mycelium.

Two distinct forms of terminal swellings occur. Small bulbous expansions of the ends of the filaments themselves are regularly met, both in the tissues and in cultures at a comparatively early stage of growth. Larger and longer pear-shaped swellings of the investing sheath may develop around the terminal filaments, and form the so-called 'clubs.' When well developed, these hyaline clubs assume a radial or stellate arrangement, and from this circumstance the name ray-fungus, or actinomyces, was derived (Fig. 280). Club-shaped swellings are more common in the tissues than in cultures, and bovine lesions show them more often than do human infections, where they may be exceedingly fragile, and therefore hard to demonstrate. In tissues, the formation of clubs appears to be associated with later stages of growth, since the colonies in which they occur are usually large, and show extensive central necrosis.

Fragmentation of the mycelium is the most common form of degenerative change in human lesions, and is seldom absent from the colonies discharged by infective sinuses. The fragments are often remarkably uniform in length, and resemble somewhat large bacilli. They have been described as "bacillary forms" of the streptothrix. When grown on culture media, however, these "bacilli" do not reproduce other bacillary forms, but develop into young branching filaments.

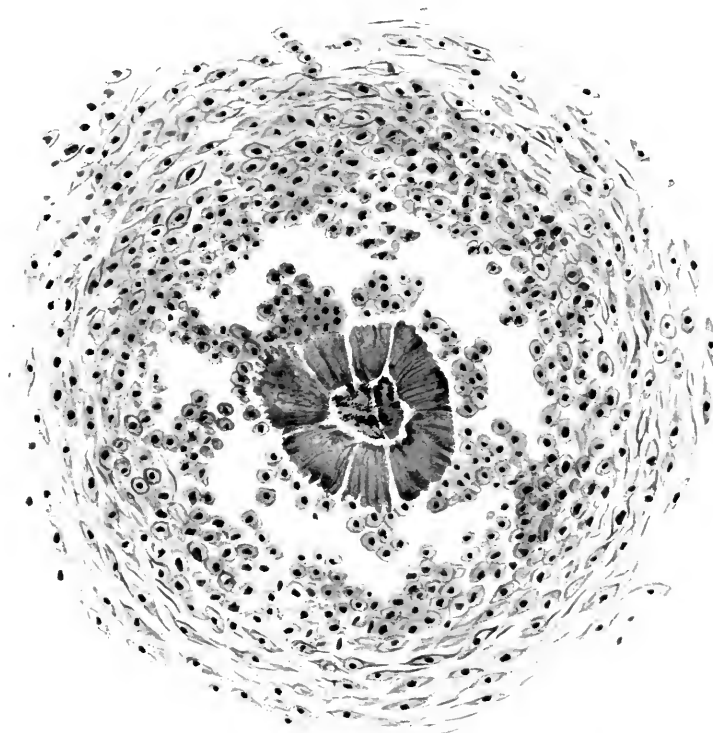


FIG. 280.—Actinomycosis of the tongue of a cow. (Sims Woodhead.)

Further fragmentation to minute coccoid bodies may also occur. The widely-accepted statement that the streptothriceae are pleomorphous is probably incorrect.

Evidences of reproduction may be seen very characteristically in cultures, and occasionally in the tissues. When the micro-organism is grown on the free surface of a culture medium, a fine powdery efflorescence may appear. This is due to the development of minute rounded spores, or gonidia, arranged in linear rows at the extremities of special aerial hyphae. When they arise in the tissues, the spores have the same general form and arrangement as streptococci. When rounded spores, bacillary fragments, and mycelial threads are present together in an infected tissue, they may give the impression of a mixed infection.

Pure cultures are difficult to obtain when a slow-growing streptothrix is associated with other bacteria. Even when a streptothrix alone is present, it often shows a marked reluctance to adopt a saprophytic existence. Some varieties of streptothrix cultivated from human lesions are strictly, or almost strictly, anaerobic (Homer Wright¹), while others grow freely in the presence of oxygen, as Welsh and Barling² and many others have found to be the case with Australian forms.

The microscopic appearances of a streptothrix, both in the tissues and in cultures, are best revealed by Gram's method of staining. Nearly all the pathogenic forms are Gram-positive as regards their filaments, fragments, and spores, and the majority are not readily stained by other means. The hyaline clubs and necrotic centres of colonies are Gram-negative, except in a few very old lesions, and take up the counter-stain. Where the clubs are very fragile, they may not be easily demonstrated except in the fresh unstained condition.

B. The Lesions.—The outstanding character of a streptothrix infection is its inveterate infectivity and progressive extension, chiefly by direct local spread, so that an enormous area of tissue may become infected, and there may be secondary disseminations (metastases) to remote parts. In the tissues each colony of the microbe occupies the centre of an infective focus, and ultimately comes to lie in a small pocket of pus within the inflamed area. By confluence of adjacent foci, the suppuration may extend until whole organs may be riddled with chronic abscesses, or a great collection of pus is formed. One of us made a post-mortem examination of a woman in whom the whole of the retro-peritoneal tissues of the abdomen had been converted into one huge abscess which extended downwards into the pelvis and upwards into the posterior mediastinum, and there were secondary abscesses in the lungs. All the lesions were due to a streptothrix. In the pus from a streptothrix infection the parasitic colonies are usually visible to the naked eye as minute granules, which may be coloured sulphur-yellow, brown, or black, but which more often have a dull whitish or greyish colour, and are soft and ill-defined. But granules in pus are not diagnostic of a streptothrix, though they are strongly suggestive.

General toxic absorption may cause fever, sweating, and wasting, but usually not until an advanced stage of the disease has been reached. Indeed, it is remarkable that so little constitutional disturbance should be associated even with extensive and long-standing infections. The general intoxication is, therefore, similar to but less severe than, that in tuberculosis.

¹ Homer Wright, *Publications of the Massachusetts General Hospital*, vol. i., May 1905.

² Welsh and Barling, "A Note on the Frequency of Streptothrix Infection in Man," *Trans. Austral. Med. Congress*, 1905, p. 383.

In abdomino-pelvic infections the clinical picture varies, but three stages may be distinguished (after Grill¹): (1) a stage of invasion or commencement, with vague abdominal symptoms which may suggest appendicitis; (2) a stage of tumour formation in the viscera or in the abdominal walls, usually in the ileo-caecal region, and seldom painful; (3) a stage of suppuration and disintegration with the formation of deep sinuses and intractable fistulae, when the tumour breaks down and discharges.

Distribution of the Parasite in Nature and Mode of Entrance in Man.—Homer Wright in America considered that the biological characters of the streptothriceae isolated by him from human lesions were incompatible with their continued existence outside the animal body, and the observations of Harbitz and Grøndahl² in Norway were corroborative. There is, however, a considerable body of evidence that the pathogenic streptothriceae are capable of saprophytic life, that they may be found on grain and straw of various kinds and on grasses, and that they gain access to man and other animals most frequently through abrasions made by such infected material. This is consistent with the fact that both in man and in other animals the most common site of primary infection is in the mouth and pharynx, especially the submucosa and periosteum of the jaw. Infection may also enter by the alimentary and respiratory tracts and through the skin.

SPECIAL CHARACTERS OF PELVIC INFECTIONS

Pelvic infections are nearly always secondary to an invasion from the intestines, most often from the vermiform appendix. In those rare cases where the first manifestation of the disease appears in a pelvic organ, the intestine is still the most likely portal of entrance. That the microbe should pass through the intestinal walls without leaving an ulcer is possible, since tubercle bacilli are known to infect the mesenteric glands in that way. Next in frequency to the direct intestinal route, is a primary pelvic invasion probably by way of the blood-stream, the microbes gaining access through the tonsil. Entrance *per vaginam* must be wholly exceptional, and indeed cannot be said to be proved, since most of the cases described are not inconsistent with infection by the intestine or by the blood.

The remarkable frequency with which the appendix is selected, is well illustrated by Foulerton.³ Out of 78 early cases in which the primary site could be determined with accuracy, he found that the infection began about the mouth and neck in 51·2 per cent of the cases, in the appendix in 25·6 per cent, in the lungs in 18·1 per cent,

¹ Grill, *Abstract, Med. Annual*, 1897, p. 99.

² Harbitz and Grøndahl, *Abstract, Lancet*, Oct. 1911, p. 1152.

³ Foulerton, *Lancet*, Feb. 1913, p. 381.

and in other parts in 5.1 per cent. He also states that in many cases the infection appears to originate in the growth of the parasite along a natural duct, with subsequent invasion of contiguous parts, as in the parotid gland and in the appendix. The anatomical relations of the appendix to the right tube and ovary and to the pelvis generally afford ready access for the parasite; and we suggest that its tendency to grow along a natural duct may explain the occasional implication of one or both tubes. Foulerton's statistics are supported by the records of the Norwegian observers quoted above, and by those of Aeland and of Rührhah, when it is considered that most of the cases classed by them as abdominal probably represent advanced appendical infections. Rendle Short¹ describes five cases of *perityphlitis actinomycotica*, and gives numerous references. The involvement of the tubes and ovaries by invasions of actinomyces from the appendix and rectum has been described by Poncet and Bérard,² and by Fehmers.³

Chenhall⁴ sums up his case of streptotrichosis of the genitalia in a young woman 20 years old, in these words: "This remarkable disease, after attacking the contents of the left side of the pelvis, infected the omentum, extended through some of the layers of the abdominal wall, and developed as a tumour in the left loin, formed abscesses and sinuses on both sides below Poupart's ligament, involved the uterus, vagina, external genitalia, rectum, and perineum, in short, it pursued a course unwitnessed in any other known disease" (Fig. 281). The clinical progress of the case pointed to an infection by the intestinal rather than by the vaginal route.

Actinomycosis of both ovaries, and of the right Fallopian tube with secondary abscesses in the liver was described in a woman 35 years old by Grainger Stewart and Muir.⁵ Both ovaries were entirely replaced by fibrous tissue enclosing small abscesses. The mucous membrane of the rectum was quite intact, and there was no communication between it and any of the abscesses, though those in the left ovary were very close to its wall. The authors consider that the genital passages formed the channel of infection, and that the case was unique inasmuch as both ovaries were affected. They refer to Zemmann's case, in which the Fallopian tube was dilated and filled with pus containing colonies of actinomyces, but since the outer end of the tube was adherent to the intestine, the infection may have had an intestinal origin. They also quote Boström's case, where one ovary was in a condition similar to that described

¹ Rendle Short, *Lancet*, Sept. 1907, p. 760.

² Poncet and Bérard, quoted by Alban Doran, *System of Gynaecology*, by Allbutt, Playfair, and Eden, 1906, p. 495.

³ Fehmers, quoted by Alban Doran, *loc. cit.*

⁴ Chenhall, *Trans. Austral. Med. Cong.*, 1908, vol. ii, p. 60.

⁵ Grainger Stewart and Muir, *Edin. Hosp. Reports*, 1893.

by them, but communicated by a sinus with the bowel, so that the parasite had probably reached the ovary in that way.

Symes Thompson¹ discusses the possibility of actinomycotic infection by the vagina in a case where there was a right pyosalpinx and the left ovary had become



FIG. 281.—Actinomycosis (streptotrichosis) of the female genitalia. (Chenhall's case.)

a bag of pus; the appendix showing signs of an old inflammation. Neuhaeuser² in 1907 stated that he could find in the literature only one case in which infection *per vaginam* was highly probable; it was recorded by Giordano in a woman with extreme prolapse of the uterus.

Taylor and Fisher³ describe a condition of primary actinomycosis of the right

¹ Symes Thompson, *Brit. Med. Journ.*, April 1907, p. 984.

² Neuhaeuser, *Deut. med. Woch.*, Sept. 5, 1907.

³ Taylor and Fisher, *Lancet*, 1909, vol. i. p. 758; and *Brit. Med. Journ.*, 1909, vol. i. p. 844.

ovary in a woman 34 years old. There was no other lesion, and complete recovery followed removal of the appendages. They trace the source of the infection to some cryptogenic focus from which the actinomyces reached the ovary by way of the bloodstream. Kelly and Noble¹ state that actinomycosis, as a puerperal infection, has once been observed in the Johns Hopkins Hospital.

TREATMENT OF STREPTOTHRIX INFECTIONS

The most effective means of treatment have proved to be (a) operative interference, (b) iodine therapy, and (c) vaccine therapy. Surgical procedures have their best chance of success when undertaken in the early stages of the invasion, and their object should be the complete removal of the diseased tissues with every precaution against extending the area of infection. Even in the later stages the work should be done as thoroughly and carefully as possible. The removal of any part of the infected mass is probably a gain to the patient, and may determine the success or failure of other means of treatment. Swabbing the raw surfaces with some powerful germicide, such as tincture of iodine, has been recommended.

Bérard² points out that potassium iodide was used for actinomycosis in veterinary practice in France long before Thomassen of Utrecht brought it into notice as a specific in 1885. The treatment has been extended to human infections with considerable success in many cases. Ochsner³ suggests that this treatment would be more successful if carried out in the definite manner recommended by veterinary surgeons. Massive doses, up to 90 grains of potassium iodide thrice daily, are given for a few days and then withdrawn for a week; again administered for a few days and again withdrawn; and thereafter repeated once a month.

Since it is probably the iodine, set free in the tissues from the iodide, that is the effective agent in combating the infection, we would suggest a trial of the nascent iodine method introduced by Curle⁴ for pulmonary phthisis. Thirty grains of potassium iodide are given every morning, and followed four hours later by one ounce of chlorine water which is repeated at intervals of two hours, until three ounces of chlorine water in all have been taken. The administration is usually well tolerated and should be continued for many months.

But the most promising of all methods of treatment is vaccine therapy which has now been used with success on many occasions. Since there are so many varieties of the microbe that may be pathogenic, it is important to prepare an

¹ Kelly and Noble, *Gynecology and Abdominal Surgery*, 1908, vol. i. p. 78.

² Bérard, *Abstract, Med. Annual*, 1899, p. 144.

³ Ochsner, *Abstract, Med. Annual*, 1906, p. 94.

⁴ Curle, *Practitioner*, Dec. 1912, and Feb. 1913; cf. also Reeve, *ibid.*, Sept. 1913.

autogenous vaccine. There are technical difficulties in the way, but they are not insuperable. Collie¹ reports the beneficial effects of an autogenous vaccine on a large actinomycotic abscess in the left iliac fossa, after potassium iodide had been given freely, but without effect, and all hope of cure had been abandoned. In an unpublished paper, from which we are privileged to quote through the courtesy of the authors, Cleland, Ferguson, and Mansfield record one successful and two unsuccessful results of vaccine therapy in streptotrichosis.

¹ Collie, *Brit. Med. Journ.*, 1913, vol. i, p. 991.



ECHINOCOCCAL INVASIONS (HYDATID DISEASE) OF THE PELVIS AND PELVIC VISCERA

By H. C. TAYLOR YOUNG, M.D., and Professor D. A. WELSH
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Introduction.—Echinococcal invasions in man are so persistent, and the encysted parasites are endowed with such a capacity for growth and for the reproduction of generation after generation, that the condition must rank among the more serious forms of human disease, notwithstanding that modern surgical technique has greatly diminished the attendant risks. Pelvic echinococcal cysts are by no means rare in the inhabitants of countries infested by the parasite. The pelvis is certainly among the less common sites of *primary* echinococcal invasion, and the viscera are less often attacked than the loose connective tissues of the pelvis. On the other hand a pelvic invasion is a common incident in the secondary dissemination of the parasites, since the primary cyst is most often in the liver, and the parasites tend to gravitate to the pelvis when it ruptures.

Secondary hydatid cysts within the pelvis may have the same local significance as primary cysts in similar positions, so long as the secondary distribution of the parasite is scanty and is restricted mainly to the pelvis. In these circumstances it does not make much difference, as regards pelvic derangement, whether the cyst has been developed primarily within the tissue, or has become secondarily adherent to it. Nevertheless, the distinction is of clinical importance, since a primary cyst outside the pelvis would be a continual menace of further dissemination, and would require separate treatment. It is this limited form of secondary pelvic invasion that is most commonly presented to the gynaecologist. It corresponds to one aspect of the condition described as a *daughter-cyst infection*. In the contrasted condition of *scolic infection* the escape of a multitude of scolices from a primary hepatic cyst results in a widespread invasion of the peritoneum, and the involvement of the abdominal area tends to dominate that of the pelvic area, although the latter may

be extensively implicated. Hence in this form the secondary invasion would have a surgical rather than a gynaecological interest.

It is not always easy to decide whether a pelvic cyst is of primary or of secondary growth. In course of time a primary cyst may work its way towards the surface of the organ or tissue in which it has developed. On the other hand a secondary cyst may become more and more closely incorporated with the same structure by progressive inflammatory adhesions. The discovery of a primary cyst in the abdomen is not necessarily conclusive of the secondary origin of a pelvic cyst, even when the extra-pelvic cyst appears the older of the two, since both may be primary, and one may date from a prior invasion. But the developmental state of the abdominal cyst might give some indication, since it might, or might not, be incompatible with a previous rupture of the cyst-wall. As a rule the distinction between primary and secondary pelvic invasions is obvious.

LIFE-HISTORY OF THE PARASITE AND CHARACTERS OF THE INVASION

The parasite concerned is one of the cestodes, or tape-worms, best known as *Taenia echinococcus*. Like other members of this class, it presents two distinct phases of development, each of which selects a different habitat and invades a different mammalian host. The mature sexual form (*enteral phase*) is never found in man, but only in the intestinal tract of certain canines, and chiefly in the dog. The immature encysted form (*parenteral* or *somatic phase*) is passed in the viscera, connective tissues, or serous membranes of various other mammals, notably in the sheep, and occasionally in man.

The adult *Taenia echinococcus* is remarkably small, measuring from 2.5 to 5 mm. in length. It is made up of a head (*scolex*), and usually three other segments (*proglottides*), though worms with one segment more or less than this may be found. The third proglottis, when sexually mature, is about 2 mm. long and larger than all the rest of the worm. The *cephalic segment* begins with a muscular rostellum armed with a variable number of hooklets, which are arranged in a double ring; then comes an expansion bearing four suckers; and it terminates in an elongated narrow neck. The hooklets of the adult have the same distinctive characters as the hooklets of the encysted scolex, though minor differences are apparent, since the hooklets tend to become stouter and stronger as the worm matures.

The next succeeding segment, the *first proglottis*, is the least developed, and is more or less ill-defined. In the *second proglottis* immature generative organs may be recognized. The *third proglottis* (forming the fourth, and usually the terminal, segment of the adult worm) is the first to become sexually mature. It contains a

complete reproductive apparatus of both male and female organs. The uterus forms a wide median tube with lateral pouches, and becomes filled with ova to the number of about 5000. Though the adult is so minute, the ova are not smaller than the average of other cestode ova, but the shell is comparatively thin. Development goes on while the ovum remains *in utero*, until the embryo, enclosed within the embryonal shell, can be distinguished by the possession of three pairs of hooked spines. No further development takes place within the canine host.

The habitat of the adult worm is the upper part of the small intestine of the dog, wolf, and jackal. The scolices burrow among the villi, and the milk-white ripe proglottides project into the lumen. Many thousands may be present in a single host; as many as 8800 were calculated by Nettleship¹ in one dog. If the proglottides are unripe, they may be confused with the intestinal villi and escape observation altogether. Ultimately the ripe proglottides are discharged, or break down in the intestine. In either case the embryos within their chitinous shells (*oncospheres*) are liberated from the canine host, and remain for a time free. They probably have considerable powers of resistance both in a moist and in a dry state.

The cystic stage of the parasite is initiated by the ingestion of the oncospheres by suitable intermediate hosts. Numerous mammalian species—twenty-seven in all have been recorded (Braun)²—may harbour encysted echinococci, and the sheep, ox, and pig are the more important in addition to man. The oncospheres, discharged from the bowel of the dog, find their way into drinking water, or on to the surfaces of herbage, vegetables, and other food-stuffs. Some doubtless become desiccated, and are air-borne in dust, and thus indirectly reach food, or are inhaled, and, lodging in the naso-pharynx, may be swallowed. In some such way the oncospheres are taken into the stomach of an intermediate host where the chitinous shells are softened and ruptured, and the hexacanth embryos are set free.

The embryo with its six-hooked spines then bores its way into the wall of the stomach or intestine. Its further course is largely conjectural. The outstanding frequency with which the liver is invaded by the cystic stage (about 60 per cent of all cases recorded in man) would indicate that the portal venous system is the most likely route (Thomas).³ The long axis of the embryo is about three times the diameter of a human red blood-cell, so that its entry into some small radicle of the portal vein and its carriage to the liver would present no difficulty. Some embryos might escape impaction in the liver and be carried on to the lungs which are the next most common

¹ Nettleship, *Proc. Roy. Soc.*, 1866, vol. xx. No. 86.

² Braun, *Animal Parasites of Man*, London, 1906.

³ Thomas, *Hydatid Disease*, Adelaide, 1884.

site of primary invasion (about 12 per cent of the whole). The embryos that succeed in passing both hepatic and pulmonary capillaries might then be distributed by the systemic arteries to other organs and tissues; but, since the total number of these systemic cysts is more than double that of pulmonary forms, it is unlikely that the dissemination of the embryos is purely mechanical and embolic. The minute size and active movements of the embryos would equally admit of complete penetration of the stomach or bowel, and their migration into the peritoneal sac and along connective-tissue planes.

By whatever route it travels to its somatic destination, the embryo ultimately comes to rest more often in some tissues than in others. It is difficult to avoid the conclusion that this selection is not wholly due to mechanical conveyance, but is influenced by some affinity between certain tissues and the parasite. In the liver probably both factors are concerned, so that the parasites not only have ready access by portal embolism, but also find a suitable environment for growth. It is probable, however, that only a small proportion of the invading embryos succeed in developing the cystic form. Primary cysts in man are either single or few in number, while the opportunities for infection in a hydatid district are continually present, and the number of living ova discharged by a single dog may be enormous. This is consistent with the fact that experimental feeding with ova frequently fails to reproduce the cysts. It would appear, therefore, that the tissues themselves exercise some restraining influence on the development of the cystic stages; in other words, that there is an appreciable degree of natural immunity to echinococcal invasions, greater in some tissues than in others. For example, the extreme rarity of hydatids in the lymphatic glands and closed lymphatic vessels is remarkable (Stirling and Verco).¹

The development of the echinococcal cyst from the resting embryo (*proscolex*) in the tissues has been described by Leuckart² in pigs fed with ripe proglottides. In four weeks, nodules resembling tubercles were found in the liver, and within each nodule the embryo had become a rounded body like a mammalian ovum, having a thick homogeneous capsule and coarsely granular contents. After eight weeks the young parasites had about doubled in size, and fluid had collected in the centre, so that a cyst, or "bladder," was already formed. The outer envelope (*ectocyst*) was laminated, but less distinctly than in later stages, and an inner granular layer was being differentiated to form the germinal or parenchymatous layer (*endocyst*). After nineteen weeks the average diameter of the parasitic cysts had increased

¹ Stirling and Verco, article on "Hydatid Disease," Allbutt and Rolleston's *System of Medicine*, vol. ii. part ii., London, 1907.

² Leuckart, *The Parasites of Man*, translated by Hoyle, Edinburgh, 1886.

to 10 mm., the fluid content was greater, but the general structure remained the same and the cysts were still destitute of heads (*acephalocysts*). So slow was the development of the encysted parasite that it was not until five months had elapsed, and the cyst had attained a diameter of 15 mm. or 20 mm., that the formation of scolices was seen. From the earliest appearance of the parasite the invaded tissues had been reacting to its presence, and had formed at each stage the corresponding adventitious capsule or *pericyst*.

The ultimate result of an echinococcal invasion—the so-called “hydatid cyst”—is therefore made up of a contribution from the parasite, and a contribution from the host. The fully-developed parasitic structure, or echinococcal cyst, is a monocyst, being derived from a single embryo. It may be differentiated into ectocyst and endocyst, from which a multitude of scolices may be developed, and forms a thin-walled unilocular cavity containing an abundant watery fluid. Its dimensions are very variable. It may measure less than an inch, or more than a foot, in diameter, the average being a few inches. In this uncomplicated form it is to be regarded as a primary or parent cyst, and multiple primary cysts may arise within the same host from simultaneous or successive invasions by the embryo.

The endocyst, or germinal layer, represents the living tissue of the parasite. On its outer surface it forms the cuticular ectocyst with which it is in direct continuity. This ectocyst is a translucent, elastic membrane, somewhat like hard-boiled white of egg, increasing in thickness with age, and showing a fine lamination so characteristic that a small fragment may lead to its identification. Being highly resistant to suppurative and degenerative changes, portions of ectocyst may be recognizable many years after the death of the parasite.

From the inner surface of the endocyst there are developed numerous small projections about 1 mm. in diameter. These are the *brood-capsules*—delicate sacs each containing several parasitic heads or *scolices*, and many thousands of scolices may be developed from one endocyst. Each scolex has the same general structure as the head of the adult worm, including the double ring of characteristic hooklets. The anterior portion of the head, bearing the hooklets and suckers, is frequently invaginated into the hinder part of the scolex. It is undecided (*a*) whether the scolices take origin from the exterior of the brood-capsules as hollow buds or from the interior as solid bodies; (*b*) whether scolices are formed only from brood-capsules, or may take independent origin from the endocyst; (*c*) whether during the life of the parasite there is absolute continuity between endocyst, brood-capsules, and scolices, as Leuckart¹ insists, or whether separation of scolices and brood-capsules from the

¹ Leuckart, *op. cit.*

endocyst is a phenomenon natural to later stages of growth and not inconsistent with their vitality.

The adventitious capsule, or pericyst, is the histogenetic contribution of the host, and represents the local product of the interaction between the parasitic cyst and the tissues. The proteins of the parasite have a remarkable power of stimulating proliferative changes in the connective tissues with which they come in contact. This is well seen in the peritoneum, and most pelvic hydatids come into relation with peritoneum, and show thick fibrous capsules with abundant adhesions.

When the parasite is healthy, the cyst-walls are under considerable tension. The fluid contents are clear and limpid, consisting chiefly of water. About one-half of the total solids is made up of sodium chloride, and the protein content is low. Free scolices may be found in the clear fluid (Fig. 282). When the parasite dies, the tension is relaxed by the gradual absorption of the water, and the cyst-walls collapse and become plicated as the adventitia contracts. Leucocytes, both neutrophils and eosinophils, are attracted by the products of the parasite, and may enter in great numbers from the adventitia. It is customary to speak of this as a suppurating hydatid although no bacteria may be present. The end-result may be complete desiccation, degeneration, necrosis, and calcification of the parasitic cyst. The hooklets are highly resistant and persistent, and their presence is diagnostic of a hydatid invasion.

The formation of *daughter cysts* from the parent cyst has hitherto been regarded as a further stage in the natural development of the parasite due to some obscure biological stimulus. It was noted that the secondary cysts might be developed within the primary cyst (*endogenous formation*) or might be formed external to it (*exogenous formation*). In the former case the cysts of the new generation were traced to vesicular expansions of the scolices or brood-capsules, or to collapse and cohesion of the endocyst. In the latter case they were traced to budding from the outer layers of the endocyst, the resultant pressure bursting the ectocyst and liberating the new cysts. It was observed that a third (or even a fourth) generation of granddaughter (or great-granddaughter) cysts might similarly be developed within, or without, these daughter cysts, presumably under the influence of the same obscure stimulus.

MacCormick¹ has suggested a definite cause for these phenomena. His experience has led him to the conclusion that the parent hydatid forms daughter cysts *only after rupture of the cyst-wall*. Our own experience enables us to corroborate

¹ MacCormick and Parkinson, "Seven Cases of ruptured Hydatids with Secondary Infection of the Peritoneum," *Journ. Univ. Syd. Med. Soc.*, 1908.

and develop this statement. On this hypothesis the formation of secondary cysts would depend upon the purely accidental, though definite circumstance of damage to the cyst-wall. The development of successive asexual generations may thus be



FIG. 282.—Fluid from hydatid cyst showing free scolices and characteristic hooklets. ($\times 260$.)

regarded as a natural provision for the survival and continuance of the cystic stage when its environment is suddenly and profoundly altered. It is possible that the factor which stimulates further cyst-formation is *direct contact with the tissues and fluids of the host*. It may be that the same stimulus is exerted by the host on an

exposed endocyst, or on liberated scolices, as on the original embryo ; and that this interaction induces the naked parasite to interpose a cuticular ectocyst between it and the host, and to develop a fresh endocyst.

This hypothesis is not only in harmony with observed facts, but offers a consistent explanation of them. (1) If the damage to the ectocyst is short of actual rupture, but sufficient to allow some of the fluids of the host to reach the endocyst in excess of the normal interchange, then a few scolices (or the endocyst directly) may be stimulated to an endogenous cystic development within the unbroken ectocyst. (2) If the ectocyst bursts into the adventitious sac, the scolices and brood-capsules escape into the space between the adventitia and the ectocyst, and the secondary daughter cysts are formed there. Some of them may develop within the partially-collapsed ectocyst. It is more common, however, to find the ectocyst completely collapsed and empty, and the sac of the adventitia crowded with tightly-packed daughter cysts, while the parent cyst falls to the most dependent part and degenerates. (3) After daughter cysts have formed within the adventitia, the internal pressure may burst the containing tissues and liberate the cysts as a *daughter cyst infection* (MacCormick). These daughter cysts are merely transferred from the primary site to various secondary sites. For the most part they fall into the pelvis and the infection is more or less limited. The parasite does not enter upon any new phase of its life-history in consequence. Each secondary cyst may continue to grow at the site of secondary implantation, but will not form tertiary or grand-daughter cysts until some damage to the ectocyst once more initiates the change, when there may be reproduced the same sequence of phenomena as follow rupture of the primary cyst. (4) When both ectocyst and adventitia rupture at the same time, then free scolices and brood-capsules escape into the tissues. This is well seen where muscle or bone has been invaded, or where a cyst has burst into the peritoneum or pleura. In such cases there is usually a widespread dissemination of scolices in enormous numbers, giving rise to a *scolic infection* (MacCormick). Each scolex may develop into a separate cyst, and the secondary cysts thus formed are structurally indistinguishable from the daughter cysts that may arise within the adventitia. Both may reproduce in all essentials the structure of a primary cyst, including ectocyst and endocyst, with innumerable scolices and brood-capsules. This condition was recognized, described, and illustrated by Graham in 1891.¹

These processes may be combined in various ways, and rupture and regeneration of the cysts (with or without re-implantation) may go on indefinitely, resulting in successive generations of parasites all in the encysted stage. The limitations to this

¹ Graham, *Hydatid Disease*, Edinburgh and London, 1891, p. 86, and Plate xxi.

development are probably due partly to the intrinsic vitality of the parasite, and partly to the resistance offered by the tissue invaded. Both of these factors are probably variable. In a few instances development is arrested in the first generation, and the primary cyst is barren, being devoid of scolices (*acephalocyst*). More often it persists to a second generation, and the daughter cysts are acephalous. But in most cases the vitality of the parasite and its capacity for regeneration are not exhausted within the lifetime of the host. Whether the development at any stage would be endogenous or exogenous would be determined by the extent of the damage to the ectocyst, and the scope of the dissemination would be conditioned by the breaking-strain of the adventitia and the nature of the tissue invaded. Obviously, opportunity must be given for damage to occur, and most often this is spontaneous, due to the increasing size and tension of the cyst. It has long been known that daughter cysts are more common in man than in the domestic animals, and the reason probably is that the shorter life of the lower animal restricts this opportunity for damage.

Whether development ceases with the formation of primary cysts, or whether it goes on to secondary or tertiary cyst formation, there is no further advance in the life-history of the parasite within the intermediate host. Not until living scolices from the endocyst have been ingested by a canine host will the cycle be completed. Then the anterior end, with its hooklets and suckers ready formed, burrows into the intestinal mucosa, the proglottides of the adult *Taenia* are developed from the posterior end, and the enteral phase is resumed.

The chief *endemic areas* are Australasia, the Argentine Republic, Iceland, and parts of the continent of Europe. As in other parasitic diseases, certain conditions are required for its prevalence. A natural reservoir of the parasite is provided by the sheep and other stock of the district. A carrier and a medium for the development of the infective stages is found in the dog. Transmission of the ova to man is conditioned by his association with dogs. Any break in this sequence would avert the disease; but the only effective means of protecting a community is to prevent dogs feeding on the offal of animals harbouring the cystic stages. It is interesting to note that in Iceland and in parts of Europe women are more often affected than men, while in Australasia the proportions are reversed. Age does not appear to predispose nor to confer immunity. The incidence of hydatid disease is determined simply by the opportunity for infection.

Echinococcus alveolaris (multilocularis) is a rare type of the invasion found chiefly in the liver of man and of cattle. We have found no record of its occurrence within the pelvis.

INTERACTIONS BETWEEN THE PARASITE AND ITS HOST

The vital reactions between the echinococcal cyst and its human host have within recent years been studied by many observers, and phenomena of pathogenic and diagnostic importance have been traced to them. The laminated ectocyst, separating the living endocyst from the fluids and tissues of the host, acts as a membrane regulating the interchange of matter in both directions (Chapman).¹ Food-stuffs pass from the host to the parasite to maintain its vitality and to admit of its growth; but, since the rate of growth and metabolism of the cyst is slow, there is no great drain on the host by the passage of matter in this direction.

The chemical processes within the cyst, however, convert the organic molecules of human origin into the new proteins that go to build up the substance of the parasite in its development from an embryo of the same order of magnitude as a red blood-cell, to a cyst that may be enormous. Human material is thus transformed into echinococcal material, so that the final products of the synthesis are biologically alien to the host. In some way also the parasite elaborates bodies which are toxic to the host. It may be that all the stimulant and toxic effects on the host are due to a definite protein of the parasite. On the other hand, it may be that a multiplicity of parasitic derivatives are concerned in the diverse effects produced in the host. In any case there is evidence of the passage outwards from the encysted parasite of a substance, or substances, which stimulate a highly complex series of reactions on the part of the host, including (1) immunity reactions and the appearance of anti-substances in the blood, (2) leucoblastic reactions of a selective type, and (3) toxic reactions. All these reactions reach a maximum when the cyst-wall is ruptured, and there is a sudden great increase in the rate of absorption of parasitic products. One or more of the reactions may be demonstrable while the cyst-wall is unbroken, but they tend to become unrecognizable during quiescent phases of growth when the interchanges are at a minimum.

1. *The immunity reactions* depend on the fact that the proteins absorbed from the parasite are biologically alien to the tissues of the host, so that a precipitin may be developed in the blood. Hence when the blood-serum of a patient suffering from an echinococcal invasion is mixed with hydatid fluid a definite and recognizable precipitate may result. In this case some constituent of the hydatid fluid (the *antigen*) has by repeated absorption produced in the patient an anti-substance (the *precipitin*), and the interaction between the precipitin-anti-serum and its specific

¹ Chapman, "Changes in the Blood of Persons infected with Hydatids," *Journ. Univ. Syd. Med. Soc.*, 1909.

antigen has led to precipitation. It has been shown by Welsh¹ and Chapman² that this precipitate is derived, not from the antigen as was formerly supposed, but wholly, or almost wholly, from the anti-serum which contains the true precipitable substance. It was also shown by them that in the precipitin-reaction the clinical pathologist has a scientific test for the diagnosis of hydatid disease within certain limits as Fleig and Lisbonne³ had indicated.

The procedure for a diagnostic test by the precipitin reaction is comparatively simple. Not less than 1 c.c. of blood should be collected in a Wright's capsule from the patient suspected to harbour the echinococcus, and the serum separated by clotting and by spinning in a centrifuge. At least twelve drops of the clear serum should be added to 1 c.c. of sterile hydatid fluid in a small test-tube (prepared from glass tubing of narrow bore so that 1 c.c. of fluid forms a column about 5 cm. high). Control tubes should be prepared, one containing the hydatid fluid and blood-serum from a healthy person in similar quantities, the other containing hydatid fluid alone. The fluid in each tube should be thoroughly mixed, the tubes plugged with sterile cotton wool, allowed to stand at a room temperature of about 20° C., and read at twenty-four and forty-eight hours. A definite white precipitate, 1 mm. or more in depth, in the tube containing the suspected serum, with no deposit in the control tubes, is diagnostic of an echinococcal invasion. A positive reaction is independent of the tissue invaded by the cyst, whether liver, peritoneum, lung, or muscle, and independent also of the nature of its contents, whether clear or purulent. A negative precipitin reaction, however, is not conclusive evidence of the absence of echinococcal invasion, as this may be due to failure on the part of the antigen (hydatid fluid) or to deficiency of anti-substance (precipitin).

The phenomenon of deviation or fixation of complement affords additional evidence of an immune response on the part of the host to echinococcal invasion. The principle of this reaction depends on the fact that the interaction between antigen and its specific anti-substance has the power of fixing or deviating complement so that it is no longer available for completing the haemolysis of suitably sensitized red blood-cells. The relation between the interacting substances and complement is quantitative, and the quantities have to be adjusted with great nicety by a series of preliminary experiments. Further, all hydatid material is not equally effective as antigen, so that a careful choice has to be made. The antigen usually selected is the fresh, or dried, hydatid fluid from a sheep. The specific anti-substance is

¹ Welsh and Chapman, *Austral. Med. Gaz.*, Jan. 1908; and *Lancet*, May 9, 1908, p. 1338.

² Welsh, Chapman, and Storey, *Austral. Med. Gaz.*, Dec. 1908, p. 653; and *Lancet*, April 17, 1909, p. 1103.

³ Fleig and Lisbonne, *Compt. Rend. Soc. Biol.*, July 1907, t. lxii. p. 1198.

found in the blood of a patient suffering from hydatid disease. Complement is obtained from the blood-serum of a guinea-pig. Sensitized red blood-cells are prepared in the usual way, so that, when acted upon by free complement, the red blood-cells undergo haemolysis. All steps of the experiment are carried out *in vitro*, and are readily demonstrable. The reaction is one of great delicacy in the hands of an expert.

In a case of suspected hydatid disease some of the patient's serum is allowed to interact with antigen in the presence of complement, and after a short time sensitized red blood-cells are added. If the serum of the patient contains a sufficiency of the specific hydatid anti-substance, then the complement will be fixed by the interaction, and no free complement will be available to haemolyze the sensitized red blood-cells which fall to the bottom of the tube leaving the superfluid colourless (*positive reaction*). On the other hand, if the serum of the patient does not contain the specific anti-substance, the complement will not be fixed by the interaction with antigen, but will be free to haemolyze the sensitized red cells which are disintegrated, colouring the fluid with haemoglobin (*negative reaction*).

Weinberg¹ was the first to undertake a systematic study of hydatid disease by means of this test, and, by careful attention to detail, he obtained positive reactions in 26 out of 27 cases of undoubted echinococcal invasion. His observations have been corroborated by many subsequent workers. Flashman and Butler² found that the reaction was not always demonstrable, and that the technique was more difficult than that required for the corresponding Wassermann reaction in syphilis, on account of the small amount of the specific anti-substance in the blood of hydatid cases. Eckenstein³ concludes that the fixation of complement in hydatid disease may be absent, either because of some defect in the method, or because the reaction is latent. The reaction has precisely the same diagnostic value as that of any other specific laboratory test, in that a positive result is definite, while a negative result is indefinite.

Weinberg and most other workers consider that in hydatid disease, fixation of complement is more sensitive than the precipitin-reaction and therefore more likely to be revealed in a doubtful case. It is probable that the anti-substance mainly concerned in the fixation of complement is the precipitin itself, though other anti-substances of unknown nature may also be concerned. In either case it is conceivable that the immune content of the blood of a patient invaded by hydatids

¹ Weinberg, *Ann. de l'Inst. Pasteur*, 1909, t. xxiii, p. 472.

² Flashman and Butler, *Austral. Med. Gaz.*, Jan. 1910, p. 6.

³ Eckenstein, *Lancet*, Aug. 6, 1910, p. 377.

might be inadequate to yield a definite precipitate, and yet might be adequate to cause fixation of complement.

2. *The leucoblastic reactions* of the human host are indicated mainly by a selective increase of eosinophil leucocytes in the blood. Eosinophil leucocytosis, indeed, is a phenomenon common to all invasions by parasitic metazoa. The first extended series of observations was carried out by Welsh and Barling,¹ who estimated the absolute number of each kind of leucocytes per c.mm. of blood, and did not rely on percentages which might be misleading. Out of 20 consecutive and unselected cases, examined before operation, they found (a) that 5 presented an excessive reaction (over 1000 eosinophils per c.mm.), (b) that 5 had a well-marked eosinophilia (over 500 per c.mm.), (c) that 5 showed either a slight eosinophilia or a high normal count (over 250 per c.mm.), and (d) that in the last 5 cases the eosinophils did not exceed the average in health, being under 250 per c.mm. It would appear, therefore, that a well-developed eosinophilia (over 500 eosinophiles per c.mm.) is an inconstant feature of the blood in echinococcal invasions, having been present only in one-half of their cases.

The greatest eosinophil reactions are met in conditions of recent rupture of the cyst, when the eosinophils may exceed 5000 per c.mm. of blood, and may form more than 30 per cent of the total leucocytes. But good eosinophil reactions may be associated with single unbroken cysts and clear fluid contents. Since there is no evidence of any special accumulation of leucocytes in these circumstances, the reactions cannot be explained as the result of a drain on the eosinophils with compensatory stimulation of the bone-marrow. An alternative, and more probable, hypothesis is that some product of echinococcal metabolism is a direct myelophil stimulant, having a selective action on the eosinophil elements. The slight amount and intermittent character of the interchanges, and the long duration of the invasion, afford the most likely explanation of the frequent absence or insignificance of this reaction.

Welsh and Barling also noted remarkable changes in the blood-picture following operation. Within a few hours there may occur a sudden post-operative fall of eosinophils, sometimes to zero, together with a sudden rise of neutrophils, sometimes over 20,000 per c.mm. Some days later this would be succeeded by a great increase of eosinophils, the *secondary eosinophilia*, usually far in excess of the number present before operation, while the neutrophils are returning to normal. Later still the eosinophil increase begins slowly to subside, and the blood-picture approximates to

¹ Welsh and Barling, *Austral. Med. Gaz.*, Aug. 1906, p. 383; and *Scot. Med. and Surg. Journ.*, Jan. 1907, p. 44.

that before operation. These observations indicate that a sudden post-operative increase in the rate of absorption of the myelophil toxin has a different selective effect on the different leucoblastic tissues. On eosinophils the immediate effect may be inhibition, with, later, stimulation which gradually passes off. On neutrophils the immediate effect may be stimulation which is relatively transient.

3. *Toxic reactions* are insignificant except where the cyst-contents have escaped into the body-cavity, so that they may be considered along with other effects of *rupture of the cyst-wall*. Escape of the cyst-contents into the tissues may be due to natural causes, or accidental injury, or operative interference. Among the more important effects of rupture, we have already considered the regeneration and dissemination of encysted parasites. Rupture of the cyst also exaggerates the normal interchanges of material between the parasite and its host, and intensifies all the reactions between them. Hence immunity and leucoblastic reactions that were unrecognizable before operation may become strongly marked after operation. But the rupture of the cyst, however produced, may cause toxic phenomena which were not apparent before. These include (a) acute symptoms in all grades of severity from fatal syncope and collapse to a passing urticaria, with or without fever, (b) local inflammatory processes (*e.g.* peritonitis) from direct contact with hydatid fluid, (c) chronic toxic effects evidenced by wasting and anaemia, in long-standing and widespread invasions.

There is a remarkably close analogy between the more acute toxic phenomena, consequent upon the rapid absorption of hydatid products, and those following similar introductions of other alien proteins. It is well known that toxic phenomena may be caused by appropriate injection of non-toxic proteins. When an animal receives one or more small doses of an alien protein (in itself non-toxic), it may develop an extraordinary degree of sensitiveness to that particular protein, so that the subsequent injection of a large dose of the same protein may have profoundly toxic effects. In such a case the animal has not been immunized, it has been sensitized to the protein, and a state of *anaphylaxis* (the antithesis of *phylaxis* or *protection*) has been induced (Richet).¹ The anaphylactic state has often been accidentally reproduced in man in the course of immunization, when, for example, a small dose of an anti-serum is given. The duration of this state may be prolonged, and, while it continues, the administration of a large dose of the same anti-serum would cause the patient to receive an anaphylactic shock, the phenomena of which are practically identical with those that may follow rupture of an hydatid cyst. In that case the normal interchanges of matter between the parasite and the host would act as the

¹ Richet, *Anaphylaxis*, Liverpool and London, 1913.

sensitizing doses, inducing the anaphylactic state, and the rupture of the cyst would provide the large fulminating dose. This hypothesis is supported by the fact that anaphylactic phenomena have been produced in animals by injections of hydatid fluid (Chauffard, Boidin, and Laroche).¹

It is unnecessary, therefore, to assume that the parasite elaborates a special toxin. All the phenomena are open to the simple interpretation that the parasitic products, being alien to the host, are therefore capable of stimulating anti-substances in response to their interactions. Indeed the explanation may be more simple still, for the same normal protein of the parasite may be the antigen concerned in the formation of precipitin and in the deviation of complement; it may also be the myelophil stimulant in eosinophilia, the sensitizing and fulminating protein in anaphylaxis, and the local irritant in peritonitis. In conclusion, it is hardly too much to say that recent work on the vital reactions between the parasite and its human host has revolutionized our ideas of the hydatid cyst. No longer can it be regarded as a somewhat inert foreign body, toxic and dangerous only when rupture occurs. It must be conceived as a living entity continually reacting with the living tissues of its host.

TOPICAL DISTRIBUTION IN THE PELVIS

Records of echinococcal invasions of the pelvic viscera must be accepted with reserve, unless some characteristic structure of the parasite has been identified under the microscope. Any cyst containing watery fluid may be described as an "hydatid" cyst, and histogenetic cysts of the ovary, Fallopian tube, and broad ligament have thus been confused with parasitic cysts. In the uterus the enlarged and dropsical villi of the chorion in the "hydatid" mole have similarly been mistaken for daughter cysts. The term "hydatid" should be used with discrimination in reference to pelvic conditions.

Secondary implantation of scolices or daughter cysts on the peritoneum in and around the pouch of Douglas is a frequent occurrence whenever an echinococcal cyst ruptures into the peritoneal sac, for the contents of the cyst tend to fall into the lower abdomen and pelvis (Fig. 283). Sometimes the parent ectocyst also escapes from the adventitia and is found lying collapsed among the viscera (MacCormick).

The great majority of *primary pelvic hydatids* take origin in the connective tissues immediately beneath the peritoneum of the pouch of Douglas, whence they spread in all directions and may come into relation with the uterus, ovaries and

¹ Chauffard, Boidin, et Laroche, "Anaphylaxie hydatique expérimentale," *Comptes Rendus Soc. Biol.*, Nov. 1909, lxvii. p. 499; *Bull. de l'Inst. Pasteur*, Dec. 1910, t. viii. p. 189.

tubes, bladder, or rectum. It is an event of the utmost rarity for an echinococcal cyst to have its primary development within the substance of any pelvic viscus. From a critical search through the literature up to 1904 Eden¹ concluded (1) that no case had then been recorded of the primary lodgment of hydatids in the uterine cavity or in the uterine walls, and (2) that there was on record, previous to his own case of tubal invasion, one case of undoubted primary hydatid disease of the Fallopian tube by Doléris, and one of the ovary by Péan. Bland-Sutton² considers that in nearly every instance the embryo-echinococcus selects for its primary habitat the subserous connective tissue rather than the parenchyma of any organ. This is

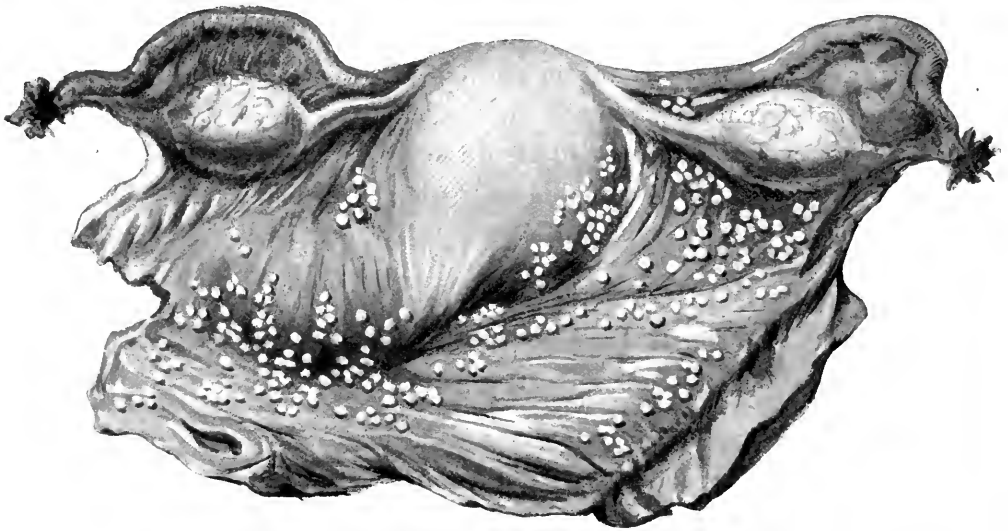


FIG. 283.—Typical scolic infection of the pouch of Douglas at an early stage. (After Graham.)

certainly true of the uterus; and nearly all cases described as growing from the ovary or from the Fallopian tube are really invasions of the loose connective tissue of the mesometrium. Subserous invasions of the hollow pelvic viscera may burrow into and ultimately perforate the wall, so that daughter cysts may come to distend the lumen, or may be discharged through it. The frequency of daughter-cyst formations in pelvic hydatids may be correlated with their liability to damage, confined as they are within the bony walls and exposed to the recurrent pressures of the pelvis.

Primary hydatids of the uterus are, with rare exceptions, subserous in origin, as Freund has shown (Fig. 285). The extent to which the uterine wall is penetrated by the cysts may give the impression of a primary intramural invasion. In the case

¹ Eden, *Journ. Obstet. and Gynaec.*, July 1904, vol. vi. p. 19.

² Bland-Sutton, *Tumours Innocent and Malignant*, London, 1906.

described by Giles,¹ the diagnosis was made of interstitial or subperitoneal fibroid; and at operation a cyst about 10 cm. in diameter, containing numerous daughter and

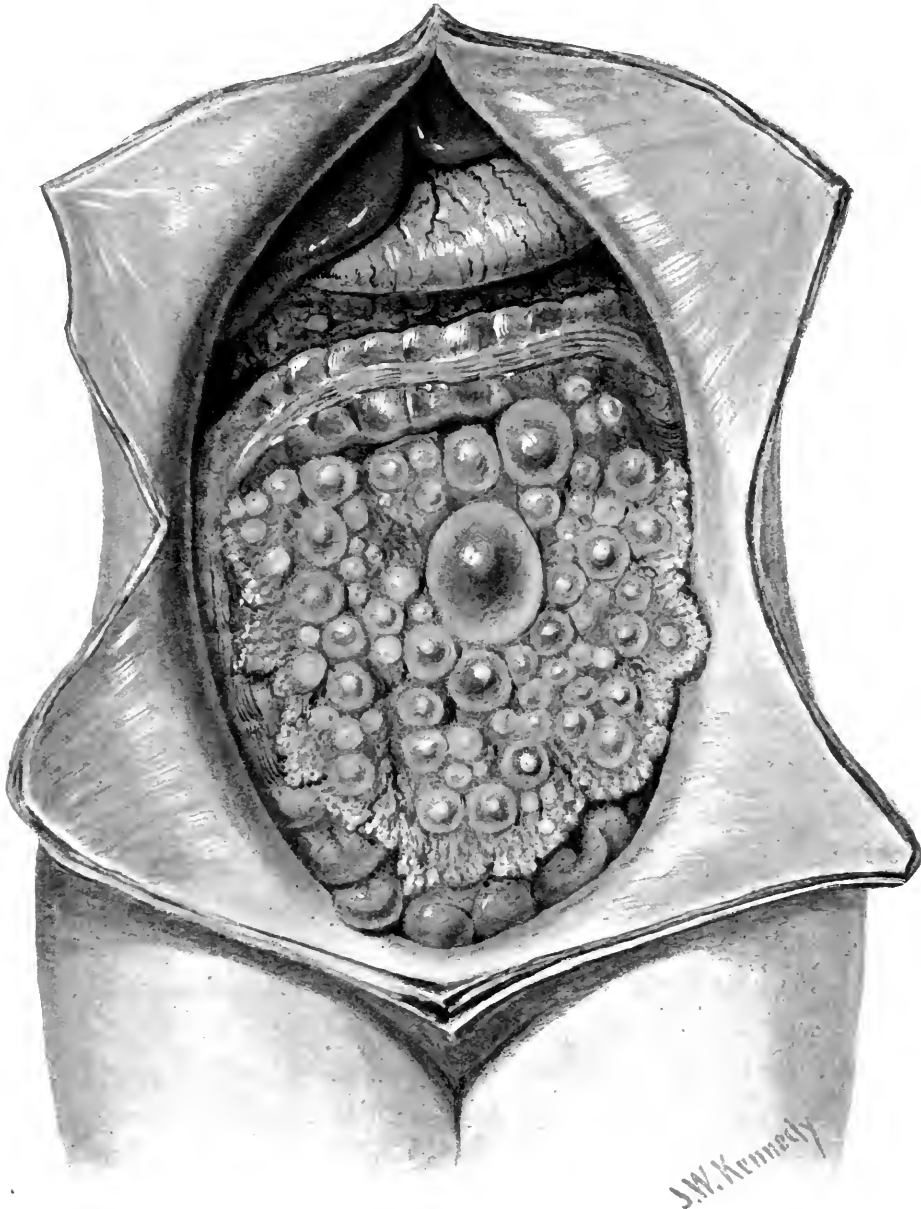


FIG. 284.—Development of secondary cysts in great numbers throughout the omentum; probably a later stage of scolec infection. The primary cyst was located in the left lobe of the liver. (Authors' case.)

granddaughter cysts, was found in the actual substance of the anterior uterine wall.

¹ Giles, *Journ. Obstet. and Gynaecol.*, June 1911, vol. xix. p. 544.

The characteristic hooklets were demonstrated. A remarkable case was recorded by Moloney¹ where subserous hydatid cysts of the uterus had eroded the muscular wall, and the daughter cysts had burst into the lumen of a Fallopian tube.

Primary hydatids of the Fallopian tube are not less rare, if subserous developments are excluded. Doléris² described a large nodular tumour depressing the pouch of

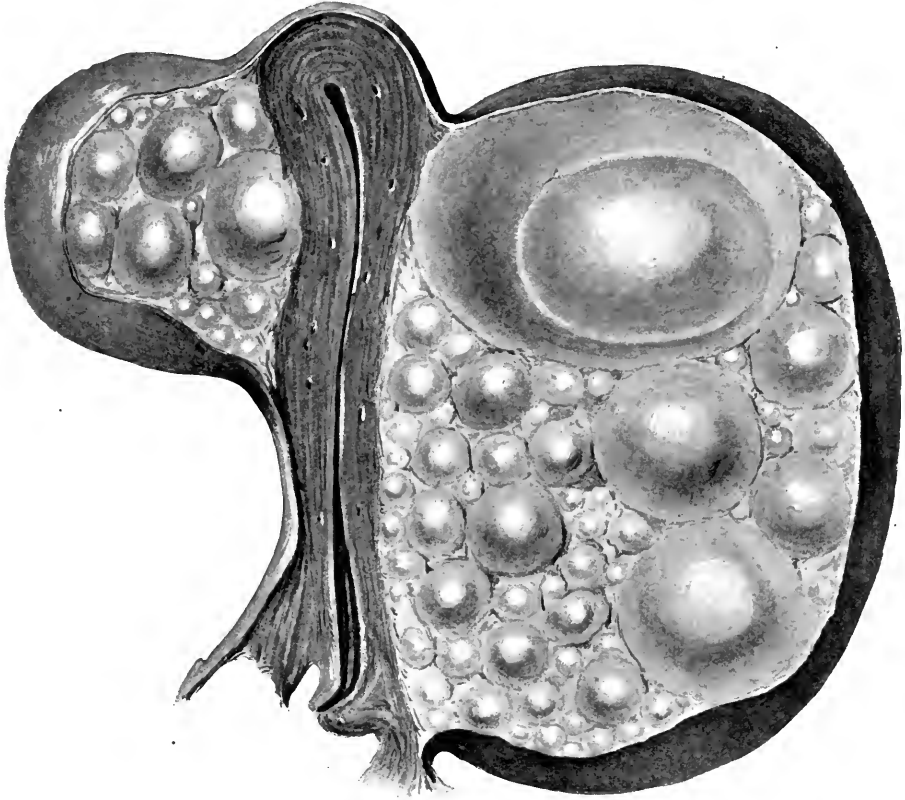


FIG. 285.—Primary subserous hydatids of the uterus with numerous endogenous daughter cysts. (After Freund.)

Douglas and extending above the umbilicus like a seven months' gravid uterus. It was thought to be a multinodular fibromyoma. At operation the mass was found to consist of the two Fallopian tubes which resembled adherent coils of small intestine. Numerous hydatid capsules crowded the lumina of the distended tubes. In Eden's case a small, tense cyst with hard walls was felt in the pouch of Douglas and was suspected to be a dermoid cyst of the right ovary. At operation a simple unilocular cyst, measuring $4\frac{1}{2}$ inches in maximum diameter, was found occupying an intra-

¹ Moloney, *Austral. Med. Journ.*, 1879.

² Doléris, quoted by Eden, *loc. cit.*

mural position in the right Fallopian tube (Fig. 286). There was no communication with the lumen of the tube, nor with the peritoneum. Characteristic hooklets and other parasitic structures were present. In the recent case observed by Dashkevitch¹

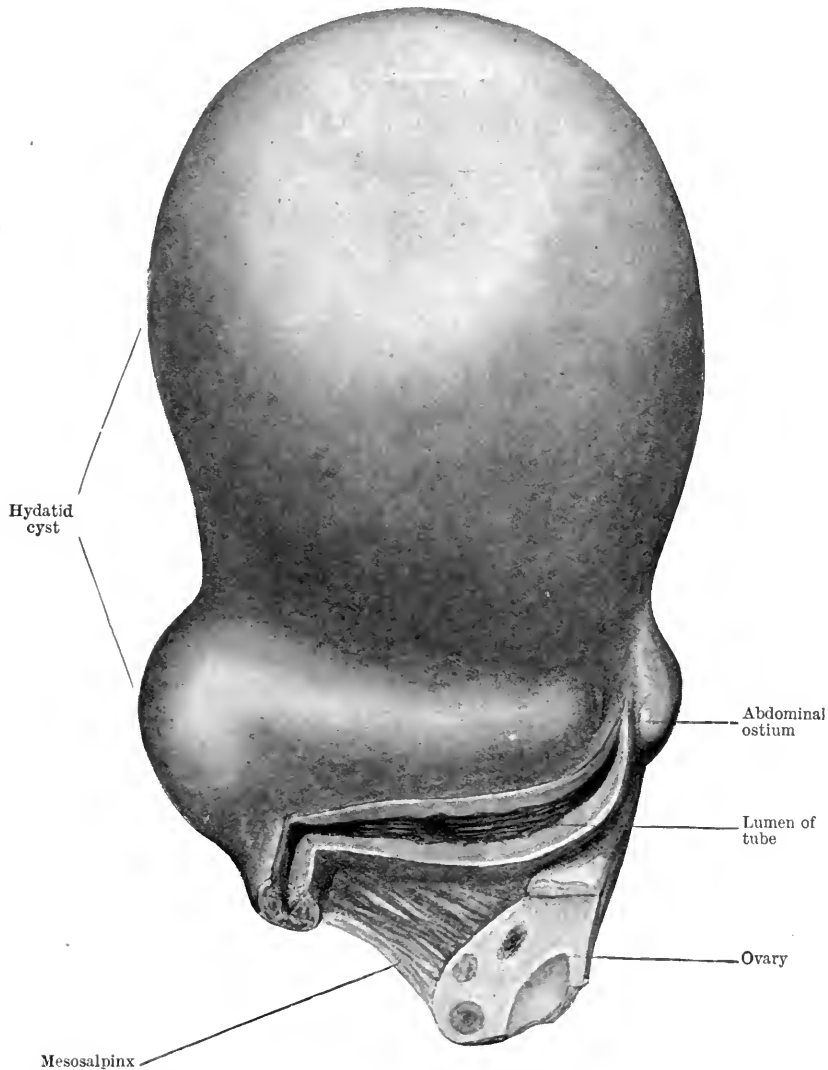


FIG. 286.—Primary interstitial hydatid of the Fallopian tube. (After Eden.)

a pelvic tumour of eighteen years' duration formed an elastic mass in the pouch of Douglas. Operation revealed an echinococcal cyst filled with daughter cysts. The left Fallopian tube was bulbous in form and distended by daughter cysts in its canal. The primary seat of the disease was not at all clear.

¹ Dashkevitch, *Abstract in Journ. Obstet. and Gynaecol.*, Feb. 1911, vol. xix, p. 282.

Primary hydatids of the ovary have been specially studied by Bland Sutton¹ who found all the records unreliable. He considers that the immunity of the ovary (and the equal immunity of the testis) to hydatid invasion is due to the fact that each lacks a loose serous investment. The case of the ovary is particularly deceptive, since hydatids arising in the broad ligament tend, by their progressive enlargement, to stretch the ovarian tissue along their periphery. Péan,² however, recorded a large hydatid cyst of the right ovary, from which 6 litres of fluid were withdrawn by

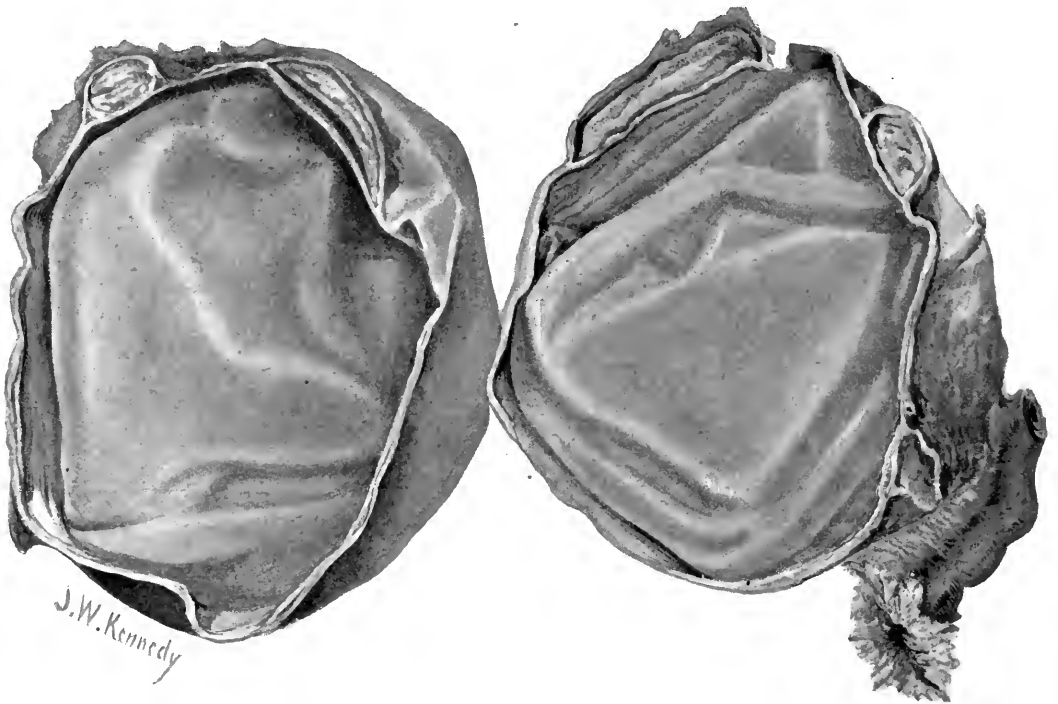


FIG. 287.—Primary echinococcal invasion of the substance of the right ovary, with two exogenous daughter cysts. The indurated condition of the hilum of the ovary is not represented. (Authors' case.)

capillary puncture. Four months later an abdominal section revealed a cyst containing 8 litres of limpid fluid and numerous daughter cysts. It was determined that the cyst originated in the ovary and had become prolonged into the broad ligament. Allen³ states that only one case has come within his experience, which is very extensive, but he does not give details.

One case of primary invasion of the ovary has come under our observation. It occurred in a woman, 29 years of age, who had abdomino-pelvic tumours for about

¹ Bland-Sutton, *Journ. Obstet. and Gynaecol.*, July 1904, vol. vi. p. 77.

² Péan, quoted by Eden, *loc. cit.*

³ Allen, *Intercol. Med. Cong.*, Melbourne, 1889.

four years. When the abdomen was opened, three hydatid cysts, each as large as a very big orange, were removed from the omentum. A larger hydatid, beneath the left lobe of the liver, was removed at a later operation. The right ovary was



FIG. 288.—Primary retro-peritoneal pelvic hydatids. (Described by Professor Watson, Adelaide.)

completely replaced by a rounded hydatid cyst between 7 and 8 cm. in diameter, adherent to the Fallopian tube, and showing several exogenous daughter cysts in its wall. The characteristic structure of the ectocyst was found both in the parent and in the daughter cysts (Fig. 287). The invasion of the ovary appeared to be due to a

strain of the parasite different from that invading the omentum, indicating that a double infection had occurred.

Primary hydatids of the pelvic bones are occasionally met. Bland-Sutton¹ refers to their eroding propensities, and cases are recorded throughout the literature where the sacrum, and other bones have been attacked.

Primary extra-peritoneal hydatids of the pelvis present an extraordinary variety in the characters of the invasion and correspondingly diverse problems in treatment. This is well illustrated by the series of cases, published elsewhere, which we have been able to collect through the courtesy of Professor Watson (Fig. 288), Drs. Worrall, Rothwell Adam, Dunbar Hooper, J. A. Cameron, Norman M'Arthur, Thomas Murphy, J. A. G. Hamilton, and T. G. Wilson. The hydatid cyst in the pouch of Douglas, described by Tate Sutherland² as obstructing labour, is also a case in point.

DIAGNOSIS OF HYDATID DISEASE

The considerations that go to make up any diagnosis may be classified as *indications* and *proofs*, and hydatid invasions of the pelvis give a perfect illustration of the difference between them. Scientific proof of an echinococcal invasion may be given in one of two ways. A microscopic demonstration of some characteristic structure of the parasite is conclusive; hence scolices, hooklets, or fragments of ectocyst yield most important evidence. It is, however, rarely justifiable to make an exploratory puncture of the suspected cyst before operation, so that, in the absence of any material discharged from the cyst, this form of proof is seldom available. As confirmation after operation it should never be omitted.

The second form of proof is given by the specific immunity reactions, including the precipitin-reaction, and the fixation of complement. With proper controls, a positive reaction of either type gives absolute proof that the human organism has been reacting to echinococcal invasion. In most cases this is the only form of proof that is legitimately available before operation. It is in a sense unfortunate that these immunity reactions are not always demonstrable even when the invasion is present, and that the proportion of negative to positive reactions in cases of undoubted hydatid disease is higher than in most other conditions which induce the phenomena of immunization. Yet it is only reasonable to expect that the anti-substances on which these reactions depend should in many cases be deficient, when the conditions of protein interchange in echinococcal invasions are contrasted with

¹ Bland-Sutton, *Surgical Diseases of the Ovaries and Fallopian Tubes*, London, 1896, p. 356.

² Tate Sutherland, *Austral. Med. Journ.*, 1912.

the conditions required for successful immunization. The maximum immune response to any substance (antigen) is obtained only when the dosage and time-intervals are carefully adjusted, as in the preparation of antitoxin, or of an experimental haemolytic or precipitin anti-serum. But the absorption of hydatid products from the encysted parasite is probably very irregular both in amount and in time. Apart from rupture of the cyst it is most often very slight. Moreover, it extends over long intervals of time—certainly for months, more often for years—before the patient comes under observation; so that the capacity of the human organism to react to small doses of hydatid products may have become exhausted. It is obvious, therefore, that a negative immunity reaction is no proof of the absence of hydatid disease.

All other sources of information open to the clinician are merely indicative and inconclusive. A systematic examination of the leucocytes is nevertheless a factor in the differential diagnosis on scientific lines. A well-developed eosinophilia is strong presumptive evidence of hydatid invasion, when, as often happens, the physical signs are confirmatory but indecisive. It is not, of course, conclusive, since eosinophil leucocytosis is not a specific phenomenon, being due to many other causes. When an eosinophil increase is slight or absent the examination must be regarded as indeterminate.

There is no necessary relation between the degree of eosinophilia and the intensity of the immunity reactions, so that either test may succeed where the other fails. From our own experience we can say that a marked precipitin-reaction may be given without eosinophilia being present; the converse has repeatedly been observed. Thus fixation of complement has failed to give a positive result, although eosinophilia was present, in cases of echinococcal invasion.

Physical Examination.—Physical examination of the patient yields evidence that is both definite and indefinite. It may reveal the presence of a mass, or masses, having certain definite characters and occupying a certain definite position in the pelvis. But the *physical characters* of an echinococcal cyst vary greatly with its size, and with the tension and thickness of its walls. A large thin-walled cyst may give the impression of fluid contents, and then it may be wholly indistinguishable from other thin-walled watery cysts that are common in the pelvis, ovarian, or parovarian in origin. Where the tension within the cyst is high, or the walls are thick and leathery, the impression is given of a solid or semi-solid mass, and the condition may simulate fibromyoma or dermoid. When the cysts are multiple, as so often happens in the pelvis, the suggestion of multiple subserous fibromyomata of the uterus is all the stronger. Moreover, the *anatomical relations* of the cyst are

not easily determined. It may be located quite definitely in a given area within the pelvis. But whether it is growing from the uterus, ovary, or tube, or whether it is intra- or extra-peritoneal, is frequently a matter that eludes the most able diagnostician. An erroneous impression is often conveyed that the mass is taking origin from a viscus when in reality it is only adherent. There is, therefore, nothing in the physical examination that is pathognomonic of hydatid disease. The diagnosis of pelvic hydatids by means of X-rays is also impracticable.

The history of the case, or other collateral evidence, may give an important indication, the most significant fact being the record of a previous operation for hydatids of the liver, or the presence of a mass in the liver consistent with hydatid invasion. An abdomino-pelvic distribution of multiple cysts is of course more than suggestive. Otherwise there is nothing in the pelvic history of a pelvic invasion that may not be paralleled by non-parasitic conditions, including its slow rate of growth.

When an abdomino-pelvic hydatid has ruptured, there may be found not only a history of the sudden disappearance of the tumour, but also the symptom-complex described by Barling and Welsh,¹ consisting of peritonitis with effusion, well-marked eosinophilia, and a fugitive urticaria.

Apart from such indications, when a tense, resilient cyst is detected in the pelvis, the balance of probability is always against echinococcal invasion, even in districts where the parasite is rife. Hence, in most cases of pelvic invasion, when modern scientific methods have not been adopted, the provisional diagnosis must inevitably be against hydatid disease, though the surgeon may have that possibility in his mind.

The misleading effects of unsupported physical data are well illustrated by the following provisional diagnoses made by surgeons of wide experience in actual cases of pelvic hydatids. They make a tolerably complete list of the possible "tumours" that may arise within the pelvis, and include (1) appendicitis, acute and chronic, (2) fibromyoma uteri, single or multiple, (3) parovarian and other watery cysts, (4) multilocular ovarian cystoma, (5) malignant new growths of ovary, (6) dermoid cysts of ovary, (7) impacted fibroid of ovary or uterus, (8) the so-called hydatid mole of the chorionic villi, (9) a pregnant uterus.

TREATMENT OF PELVIC HYDATIDS

It is impossible to lay down hard and fast rules for the treatment of pelvic hydatids. What must strike any one reading the literature, and what has impressed us in the accounts received from many surgeons in Australasia, and in our own

¹ Barling and Welsh, *Austral. Med. Gaz.*, July 1910, p. 349; and *Lancet*, Oct. 1910, p. 1001.

experience, is the extreme variety of the phenomena presented by different cases. It is hardly too much to say that not one case of pelvic hydatids is like another. Therefore the details of treatment appropriate to each individual case must be left to the common sense and discretion of the operator. Here, if anywhere, the gynaecologist must have some of the experience of the general surgeon before he can cope successfully with the invasion. For the pelvic condition is often not the only manifestation of the hydatid disease, and he must be prepared to deal with all the lesions which present themselves. At the same time it is possible to indicate certain general principles on which definite forms of surgical procedure have been based.

1. *Aspiration or tapping of the cyst*, as a mode of treatment, has fallen into desuetude. Experience has revealed a long train of disasters which may follow its injudicious use, the immediate symptoms being suggestive of anaphylactic shock, the ultimate risk being a wide dissemination of the parasitic cysts. At the Fourth and Fifth Intercolonial Medical Congresses of Australasia this method was fully discussed, and the result has been an emphatic and universal condemnation of the operation. Barnett,¹ however, maintains that there are still two indications for tapping: if the patient absolutely refuses a cutting operation, but is willing to stand the risk of tapping; and again, if cysts are found in a situation where it is impracticable to do anything else but tap them. He mentions two points in the technique which should be observed in order to diminish the risk of leakage. The needle should be of very small calibre, and the cyst should be emptied of fluid as completely as possible.

2. *Marsupialization of the cyst* was introduced by Lindemann² in 1871 as an expedient for dealing with a cyst which he was unable to remove. The sac was incised, its contents evacuated, and the lips of the wound in the fibrous capsule were securely attached by sutures to the edge of the parietal incision. This method has been widely adopted with modifications, and is specially applicable to parent cysts. MacCormick recommends that, in marsupializing a hydatid cyst, the adventitious sac should be stitched to the parietes by means of a series of mattress sutures, which should include the adventitious sac and the serous and muscular walls of the abdomen, but not the skin. If there is a large wound in the abdominal wall, it should be closed, leaving room only for the drainage.

3. *The no-drain operation* was described by Bond³ in 1891 as a means of treating hydatid cysts which are still living and growing, and which contain clear fluid with or without daughter cysts. The method is based on incision of the adventitia

¹ Barnett, *Proc. Austral. Med. Congress*, Auckland, 1914.

² Lindemann, quoted by Thomas, *Intercol. Med. Cong. of Austral.*, 1889.

³ Bond, *Brit. Med. Journ.*, 1891.

(pericyst) and complete evacuation of the cyst-contents without subsequent drainage, or with only temporary drainage for a few hours after operation. It is essential that every trace of the parasite and its products should be removed, including the ecto-cyst. The inner surface of the adventitious sac is thoroughly cleansed, and the inverted edges of the incision closed by sutures. It may be advisable in certain cases to fix the sutured pericyst, so that its cavity may be easily reached should necessity later arise. But in most cases recovery is uninterrupted. The governing principle would appear to be that, if the parasitic elements are completely removed, the tissues of the host (including the adventitious sac) may be left to make good the damage, so that drainage is superfluous. This procedure, with various modifications of technique, has been widely adopted by surgeons throughout Australasia and the Argentine. It is claimed by them that the result has been to reduce the mortality, to accelerate convalescence, and to minimize post-operative complications.

Barnett, for example, describes the following procedure in dealing with simple unilocular cysts. All precautions having been taken to prevent contamination with escaping fluid and scolices, the cyst is tapped by a trochar and cannula, and, when the fluid has ceased to flow, the cyst is refilled with a 1 per cent solution of formalin to kill the remaining scolices, after the method of Dévé. The pericyst (adventitia) is then incised, and all the parasitic membranes delivered through the incision. The cavity is thoroughly dried out, the opening in the pericyst closed by sutures, and the line of sutures anchored to the abdominal wall as a precautionary measure.

MacCormick recommends a somewhat different course. He states that it is better to remove the cysts entire, whenever that is practicable; but, in situations where the cysts are very adherent to viscera, it is better to lay the cyst open, guarding the peritoneal cavity from infection, remove the hydatid cyst, clean out the adventitia thoroughly, and replace it in the abdomen, so that any serum that exudes from its walls may escape readily into the abdominal cavity. This, he says, is better than sewing up the opening in the adventitia before dropping it back, for then it may fill up with serum, which may lead to suppuration.

4. Not every case of hydatid invasion, however, is suitable for this ideal operation. *Some form of evacuation and drainage*, with or without marsupialization of the pericyst, must be adopted in certain circumstances. Suppuration is usually held to contra-indicate the no-drain technique, but, as we have seen, pyogenic bacteria are not necessarily present, and cases have been recorded where a "suppurating" hydatid cyst has been successfully closed without drainage. Effusion of bile, or excessive haemorrhage from the cyst-wall are greater obstacles to the immediate closure of the incision. So also are old multilocular cysts from which

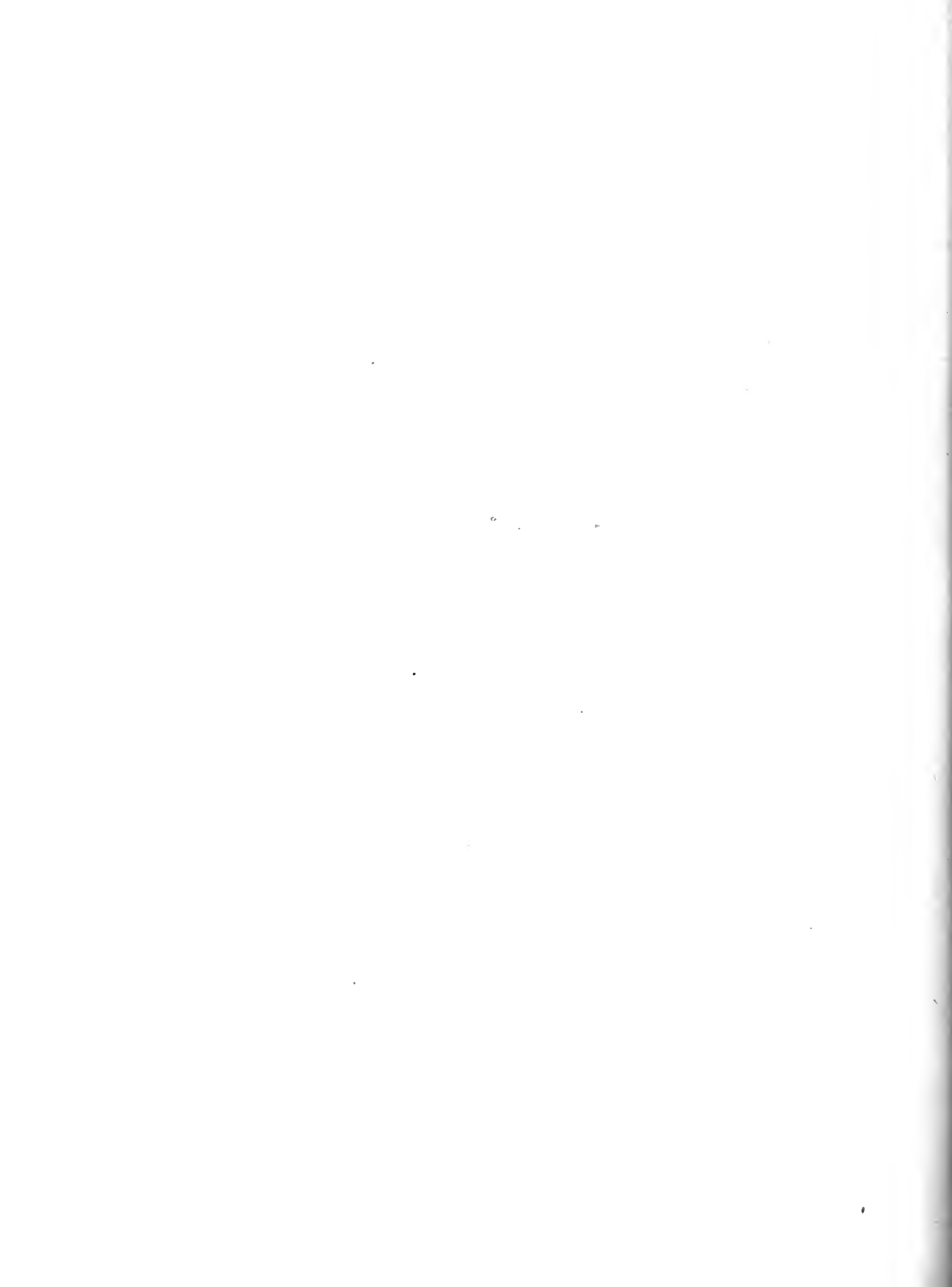
the parasitic products cannot be wholly removed at the first operation, and old cysts where the adventitia itself has become so tough, leathery, or calcified that it does not readily collapse when the contents have been cleared out. Cysts, complicated by rupture into a hollow viscus, also require to be drained. Where drainage is required the vaginal route is the channel of selection wherever practicable.

5. *Complete removal of the cyst* and all its membranes, including the adventitious capsule, with or without removal of any viscus or tissue implicated, is sometimes the simplest solution of the difficulty, and may be in the best interests of the patient. Invasions of the uterus, ovaries, tubes, and broad ligaments are best treated by this heroic method.

It is sometimes advisable to empty, or partially empty, the cyst before attempting its complete removal or drainage. Simple cysts may be evacuated by means of an aspirator before incising the adventitia. Compound cysts should be incised and the daughter cysts thoroughly cleared out by means of a teaspoon, dessert-spoon, or tablespoon, as recommended by MacCormick.

The prevention of post-operative recurrences is the most important consideration, whatever mode of treatment be undertaken. Most of the recurrences after operations on echinococcal cysts may be attributed either to accidental dissemination during the manipulation, or to incomplete removal of the parasitic structures. To protect the edges of the wound, we recommend the use of sterile pads of *vegepercha* covered with gauze, where the incision is sufficiently large to admit of their being applied and kept in position with temporary sutures. Otherwise the edges of the wound must be thoroughly washed at the completion of the operation. The abdomino-pelvic cavity should be carefully guarded by packing with aseptic pads of absorbent material. The opening in the cyst-wall should be held as close as possible to the abdominal incision while the cyst is being emptied. Various methods of sterilizing the cyst-contents have been recommended, including the use of formalin, iodine, and other parasiticidal agencies. It is obvious that such methods can be effective only in the case of simple cysts, and that daughter cysts are not likely to be destroyed during the short period allowed by the anaesthesia. MacCormick has occasionally applied pure carbolic acid to the inner surface of the adventitia, and neutralized it afterwards with spirit as in the treatment of a chronic abscess. As a general rule, however, the operator should rely on the mechanical removal of every trace of the parasite rather than on any attempt to destroy its vitality.

We are indebted to Dr. J. W. Kennedy for his excellent illustrations.



NERVOUS DISEASES ASSOCIATED WITH MORBID CONDITIONS OF THE PELVIC ORGANS IN WOMEN

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IN considering the affections of the nervous system which occur as complications or sequelae of diseases of the female pelvic organs, we exclude at the outset mere cases of coincidence, where a patient suffering from some pelvic disorder, happens also to have a coexisting nervous malady or *vice versa*. We shall therefore confine ourselves mainly to those nervous diseases which are directly induced or aggravated by pelvic disorders.

A. *Organic*—

- | | | |
|------------|---|--|
| Central | { | Tumours (metastatic). |
| | | Tabes and Disseminated Sclerosis. |
| | | Vascular lesions of Spinal Cord and Brain. |
| | | Chorea. |
| Peripheral | { | Eclampsia. Epilepsy. |
| | | Neuritis. |
| | | Neuralgia. |

B. *Functional*—

- Hysteria.
- Vaso-vagal attacks.
- Neurasthenia.

C. *Mental Diseases*—

- Insanity of Pregnancy.
- „ Puerperium.
- „ Menopause.

A. ORGANIC DISEASES

Organic diseases are occasionally met with, both in the central and peripheral nervous system.

Secondary Tumours.—Malignant growths in the breast, uterus, or ovary may produce secondary growths within the nervous system. Such metastatic deposits are often multiple. They may occur either on the surface or as deep-seated masses

within the brain or spinal cord, producing signs and symptoms, sensory, motor, and reflex, which generally enable us to recognize their situation. In many cases, however, when the growths are multiple, besides affecting parts which produce recognizable signs and symptoms, they may also affect 'silent' areas of the brain, without producing additional focal symptoms. Metastatic growths are commonly situated in the meninges or bones, in which case, in addition to the focal signs and symptoms corresponding to a lesion of the brain or spinal cord, pains are usually an outstanding feature.

Secondary tumours within the nervous system can often be accurately localized, but the fact that they are secondary renders them unsuitable for surgical removal. Now and then it happens that a patient develops signs of tumour of the brain or spinal cord without a history of a primary antecedent growth in the pelvic organs or elsewhere. In such cases error is unavoidable, and it is only at operation or autopsy that the metastatic nature of the growth becomes manifest.

Degenerative Diseases.—Primary degenerative diseases of the nervous system, notably disseminated sclerosis and tabes dorsalis, are often acutely aggravated by pelvic disease and especially by pregnancy. In patients suffering from such maladies, pregnancy should be carefully avoided. Fortunately for women, tabes is less common in them than in men. Moreover, it is relatively uncommon for tabetic women to become pregnant. If they do, the syphilitic taint may be transmitted to the child, where it can be recognized either by the ordinary clinical signs or by the Wassermann reaction in the blood and cerebrospinal fluid.

Transverse Spinal Cord Lesions.—Acute transverse lesions of the spinal cord occur occasionally in women who are already pregnant. Some of these cases are due to acute softening from syphilitic endarteritis. More frequently they are traumatic in origin, resulting from fracture-dislocations of the vertebral column. Such cases, whether due to softening or to trauma, with complete sensory and motor paralysis of the lower limbs and lower part of the trunk, may go on to full term. Save for the absence of contraction of the abdominal muscles during the second stage of labour, parturition is otherwise normal. Moreover, owing to the presence of anaesthesia, it is absolutely painless. The child may be congenitally syphilitic in cases of syphilitic softening of the mother's spinal cord. In cases of traumatic transverse lesions, the child is sometimes killed in utero by the original trauma. Labour may occur prematurely shortly after the accident, or the pregnancy may run to its full term.

Other Vascular Lesions.—Vascular lesions of the brain or spinal cord sometimes occur during pregnancy and the puerperium, producing hemiplegic or para-

plegic symptoms. Such cases are most often due to arterial thrombosis. This is sometimes syphilitic in origin ; in other cases it is perhaps attributable to excessive coagulability of the blood.

Chorea Gravidarum.—Chorea has a special tendency to be aggravated during pregnancy. Chorea gravidarum may appear in previously healthy young women, or in patients who have already suffered from articular rheumatism or from chorea in childhood. The choreic symptoms generally make their appearance in the earlier half of pregnancy, most commonly from the third to the fifth month. The patients are usually young primiparae under 25 years of age. Unmarried girls are more often affected than married women, and doubtless the distress of an illegitimate pregnancy is a factor in aggravating the chorea. Nevertheless, the connection between chorea and pregnancy is a close one, inasmuch as when the pregnancy comes to an end, whether at full term or prematurely, the choreic symptoms rapidly clear up. Not infrequently chorea reappears during subsequent pregnancies. In rare cases chorea has been observed to appear during the puerperium or after an abortion. Such cases occur generally in somewhat older patients.

Eclampsia.—Puerperal convulsions (so-called eclampsia) constitute an epileptiform syndrome of toxic origin, occurring either towards the end of pregnancy, or during labour or just after it. The disease is commonest in primiparae and is highly dangerous, the mortality amounting to 20 or 30 per cent. It is apparently the result of the auto-intoxication of pregnancy, and is probably predisposed to by renal insufficiency.

There is often a premonitory stage of headache and drowsiness, probably of uraemic origin. Then the patient complains of epigastric pain and causeless vomiting. The urine is scanty and loaded with albumen. The convulsive phenomena are not quite like ordinary epilepsy, inasmuch as there is no initial cry or sudden unconsciousness. They usually begin with slight irregular twitchings of the face, tongue, or limbs, followed in a few minutes by severe tonic spasms, the two sides of the body often being affected, not simultaneously but successively, the head and eyes being rotated towards the side of the tonic spasm. Then follows the clonic stage, like ordinary epilepsy, with tongue-biting and incontinence of sphincters, constituting a *status epilepticus*.

Venesection or venepuncture is urgently called for, and if labour has not yet occurred, it is generally advisable to induce it without delay. Withdrawal of cerebrospinal fluid by lumbar puncture also has a markedly beneficial effect. Pilocarpin and purgatives assist in clearing up the renal congestion. If the patient survives, recovery is usually complete, the kidney inflammation clearing up entirely.

Epilepsy.—Idiopathic epilepsy is not infrequently influenced by menstruation, in that the fits sometimes tend to occur before, during, or just after the menstrual period. Sometimes this is so marked as to afford an indication for specially assiduous treatment at such times, but it must be confessed that cases of this sort are in a small minority. Sometimes pregnancy in an epileptic woman is associated with temporary cessation of the fits, and cases have been known where such cessation recurred during successive pregnancies, the fits appearing again during the non-gravid state. Here also, cases of this sort are numerically rare.

There is no sufficient evidence to associate epilepsy in any special way with diseases of the pelvic organs, although diseases of the uterus or ovaries, like any other form of peripheral irritation, may serve to aggravate certain cases of epilepsy.

Peripheral Nerve Lesions.—Affections of the peripheral nervous system are occasionally met with in association with uterine or ovarian disease. Mechanical pressure on the lumbo-sacral roots may be produced by tumours, or by inflammatory conditions within the pelvis. In all cases of obscure neuralgic pain in the distribution of the sciatic nerves it is worth while bearing this fact in mind. Thus, for example, a lady of 35 complained of inveterate paroxysmal pains in the right buttock, spreading down the back of the thigh. This pain was aggravated by hunting and by suddenly rising from the sitting posture. No sensory, motor, or reflex abnormality was present in the lower limbs, but pelvic examination revealed a hard elastic mass attached to the uterus and pressing against the posterior pelvic wall. This proved to be a sub-peritoneal fibroid, the removal of which promptly relieved the pain.

It is a common experience to find pelvic cellulitis associated with sacral pain, sometimes radiating down the backs of the thighs, such pain clearing up when the cellulitis is relieved.

Pressure Neuritis.—Lesions of the sacral nerve-trunks are sometimes produced by prolonged pressure of the foetal head during labour. The following is an illustrative case :

A primipara aged 27 had a prolonged labour requiring forceps. On the day after the birth the patient began to have tingling pain and subjective numbness of the feet and ankles, with hyperaesthesia of the soles and inability to move the feet. The motor weakness rapidly extended, so that, when seen four weeks later, there was marked paresis of hips, knees, ankles, and toes, with total paralysis of the dorsiflexors of the ankles and extensors of the toes. The knee-jerks were present, the ankle-jerks were absent. There was marked wasting of all the muscles below

the knees. Under massage and electrical treatment the patient made a complete recovery.

Other Varieties of Neuritis.—Occasionally the trunks of the sacral plexus are directly infiltrated by malignant growths spreading from the pelvic organs. In such cases, in addition to severe pains, we usually have signs of organic neuritis in the form of anaesthesia, muscular weakness, and wasting, with diminution or loss of deep reflexes. The symptoms generally begin unilaterally and may remain confined to one side. Even if the nerve-trunks on both sides become affected, the condition usually remains asymmetrical.

Peripheral neuritis of septicaemic origin, due to puerperal sepsis, to infection after abortion, or even following pelvic operations, is occasionally met with, and presents the classic signs and symptoms. Its onset may be acute, within a few days or weeks after the infection, or it may come on insidiously. The patient complains of numbness and tingling of the extremities. Both the lower and the upper limbs may thus be affected. The muscles and nerve-trunks become exquisitely tender on pressure. Later we observe cutaneous anaesthesia of "stocking" and "glove" distribution. Together with blunting of sensation to light touches and pricks, there often coexists hypersensitiveness of the soles and palms to deep pressure. Paralysis of the dorsiflexors of the feet and of the extensors of the wrists appears, with the characteristic foot-drop and wrist-drop, the feet being usually more severely affected than the hands. The paralysed muscles undergo wasting. The ankle-jerks and knee-jerks disappear. The weakness may spread to other muscles in the lower limbs, so that walking becomes impossible, and in prolonged cases, unless carefully prevented by suitable splints or supports, the knees and ankles may become fixed by contracture in such a posture that, even when the paralytic phenomena have cleared up, the patient remains unable to walk until the contracted muscles and joints have again been rendered supple by assiduous massage and exercises. Even in severe cases of peripheral neuritis, the sphincters remain unaffected. The course of the disease is a slow one. Even when the source of septic infection has been removed, it may be three or six months, or longer, before the motor power completely recovers. The sensory symptoms usually clear up sooner than the motor weakness.

B. FUNCTIONAL DISEASES

Let us now consider the so-called functional nervous diseases which occur in association with pelvic disorders.

Hysteria.—In the days of Hippocrates and of Plato many of the phenomena of hysteria were already recognized and were clearly distinguished from those of

organic disease. As the name implies (*ὑστέρα*, uterus) they were referred to the uterus, which was supposed to move about, leaving its normal position and straying towards various parts of the body, *e.g.* to the throat, producing the *globus hystericus*, to the head, producing the hysterical fit, and so on. This crude theory has long since been discarded by modern medicine, and the symptoms of hysteria are now commonly attributed to psychological factors, of which the most important consists in an excessive impressionability, evidenced by a want of proportion between the intensity of a stimulus and the strength of the resulting reaction, so that the hysterical individual is abnormally responsive to certain suggestions, whether from the outer world or self-induced (auto-suggestion). Within the last thirty years, however, the genital organs have again come into special prominence, and there has arisen a fresh doctrine of hysteria, elaborated by Freud and his followers, according to which the symptoms of hysteria are supposed to originate from some old emotional trauma, generally of a sexual nature, in the patient's past life. The memory of this incident is supposed to be still active but "repressed," *i.e.* it has passed from the patient's conscious to her subconscious memory. According to Freud's school, if this original exciting incident—the skeleton in the secret cupboard of the mind—can be dragged forth to the light of consciousness, and if the emotion stored up by the old sexual incident can be poured forth in words, tears, or other emotional phenomena, by a process of mental katharsis, the hysterical symptoms which represent the "repressed" emotion will then disappear. Hysteria due to repression from consciousness of disagreeable ideas is termed a "defence-neurosis," being supposed to protect the hysterical patient from objectionable memories.

This is not the place to discuss *in extenso* the relative merits of the various theories of hysteria. The subject is admirably treated by Ormerod in his masterly Lumleian Lectures.¹ Suffice it here to say that to the unbiassed physician a certain proportion of hysterical cases appear to have a sexual basis. To claim, however, that a sexual factor is invariably present, to ignore other non-sexual, physical, or emotional shocks, to disregard the profound influence of heredity, etc., is to draw a grotesque and unphilosophical picture of this disease.

Passing now to the relation between hysteria and pelvic disorders, as shown by clinical experience, we find as a matter of practice that hysterical phenomena are less frequently associated with structural lesions of the pelvic organs than with minor, and often transient, disorders of their functions. Puberty, menstruation, and the menopause, altogether apart from pelvic disease, are times at which hysterical phenomena are undoubtedly specially frequent, but there is no evidence

¹ *Lancet*, 1914, April 25, May 2, and May 9.

that uterine displacements, pelvic inflammation, or other local troubles induce hysteria.

Hysterical *anorexia nervosa*, where the patient's distaste for food may lead to a profound degree of emaciation, is often associated with amenorrhoea. Anorexia nervosa arises more commonly at puberty and during adolescence than in later years. Some of the cases are associated with a phobia of getting fat rather than with a mere distaste for food. For example, a girl of 15, of Jewish race, had for twelve months been refusing sufficient food. Within two months she lost twenty-eight pounds in weight. The first menstrual period occurred at the age of 12, since when she had only menstruated once again, at the age of 14. There was nothing to point to organic lesion of any pelvic organ. A rest-cure, with massage, isolation, and careful feeding, restored her weight for a time, but on returning to boarding-school, the distaste for food recurred, and again she began to emaciate. On further enquiry at this stage it was found that she had a phobia of becoming fat and especially of developing in the region of the breasts. She had once seen a stout Jewess with specially large mammary glands, and this seemed to revolt her. Further, the patient was liable to paroxysms of sexual excitement, sometimes spontaneous, sometimes self-induced, dating from the age of ten or eleven years. A case like this might fairly be claimed by the Freudian school as an example of a defence-neurosis, in view of the strong sexual tinge in the history, whilst more prosaic physicians might regard the amenorrhoea following the arrival of puberty as an important factor calling for treatment.

Hysterical fits, with their emotional outbursts and wild purposive movements (kicking, biting, struggling, etc.), are undoubtedly more common immediately before, during, or immediately after, a menstrual period, but are by no means confined to such times. Emotional instability is liable to be exaggerated at the menstrual periods, and it is interesting to note that a considerable proportion of suicidal attempts in women occur during menstruation.

Amongst the stigmata of hysteria, tenderness on pressure in the inguinal region is one of the commonest. From some supposed connection with the ovary, this has been called 'ovarian' tenderness, but there is no evidence that the ovary has anything whatever to do with it. The symptom is as frequent in male hysterics as in females.

We also meet with *climacteric hysteria*,¹ although much less frequently than at puberty. It is relatively commoner in association with the artificial menopause, where, for surgical reasons, the uterus and ovaries have been removed, than where the organs undergo spontaneous physiological involution. Thus, for example, an

¹ This subject is also dealt with in the Article on Disorders of Function (p. 385).

unmarried woman aged 36, who at the age of 34 had panhysterectomy performed for uterine fibroids, after the operation developed violent, coarse, rhythmic tremors in the right leg and arm, together with a frequent subjective feeling of a tight band compressing her throat, just below the base of the skull. She also had a frequent phobia that the house was going on fire. Life seemed "unreal," and she felt as if haunted by some evil spirit. The skin had become dry and the hair of the scalp was becoming thin. Treatment by ovarian extract had considerably alleviated her symptoms when seen six months later. She then disappeared from observation, and I do not know her subsequent history.

The natural menopause is sometimes associated with the appearance of hysterical symptoms, more commonly in spinsters than in married women or widows. Thus an unmarried woman who belonged to a nervous, migrainous family, and in whom the periods ceased at the age of 45, gradually developed weakness and unsteadiness of the legs, with a peculiar tender feeling all down the spine. When examined at the age of 50 she was of poor nutrition, and had a feeble gait, neither spastic nor ataxic, with brisk knee-jerks and ankle-jerks but without ankle-clonus. She was free from cutaneous anaesthesia or analgesia. The plantar reflexes were absent but the abdominal reflexes were brisk. There was no sphincter trouble. There was some tenderness on light pressure on the upper lumbar vertebrae, but no rigidity of the spinal column. Under massage, feeding, counter-irritation over the tender spines, with bromide and valerian internally, she steadily improved and completely lost her hysterical paraplegic symptoms.

Vaso-Vagal Attacks.—The menopause is specially associated with a curious paroxysmal variety of functional nervous disturbance, the so-called vaso-vagal attack, the symptoms of which are apparently due to an affection of the vagal distribution of the cranial autonomic nervous system. The attack generally begins with an epigastric aura, quickly followed by violent irregular and rapid beating of the heart, together with a sense of suffocation and sometimes a feeling of impending death. Meanwhile the limbs become icy cold, followed either by burning flushes or by clammy sweat, with a distressing sensation of tension in the muscles. These paroxysms, varying in duration from a few minutes to several hours, recur at irregular intervals. They can often be alleviated by small doses of nitroglycerin.

Short of severe vaso-vagal attacks, as above described, a very large proportion of women at the climacteric suffer from a minor degree of symptoms of the same sort and probably of similar causation, notably flushings of the face, neck or trunk, epistaxis, transient palpitation, and so on. These are so commonplace as to be almost physiological, representing the reaction of the autonomic and sympathetic divisions

of the vegetative nervous system to the new conditions of metabolism resulting from the withdrawal of the ovarian internal secretion.

Neurasthenia.—The syndrome known as neurasthenia or nervous exhaustion is not a primary disease, but is the result of some antecedent physical or emotional strain. Amongst the many bodily disorders which can produce neurasthenia, diseases of the pelvic organs, and especially chronic diseases, are a well-recognized class. Dysmenorrhoea and menorrhagia from any cause, pelvic peritonitis or cellulitis, displacements of the uterus or ovaries, inflammatory or malignant affections within the pelvis, and so on, are all capable of producing symptoms of neurasthenia. These symptoms are chiefly subjective in character, comprising undue fatigue, feebleness of attention, "brain-fag," gloomy spirits, loss of emotional control, etc. The most outstanding symptom of all is asthenia or excessive tendency to fatigue. There is never, however, any true motor paralysis. The sensory symptoms comprise innumerable subjective sensations, all of them disagreeable. Cardio-vascular symptoms are common, including palpitation and a curious violent pulsation of the abdominal aorta, which may feel as if almost subcutaneous. Gastro-intestinal atony is also common, almost invariably accompanied by gastric dilatation, anorexia, dyspepsia, and constipation. The deep reflexes are often exaggerated, but there is no true clonus, and the plantar reflexes remain of the normal flexor type. The general nutrition is generally much below par, most neurasthenics being emaciated, although exceptionally we may meet with a plump neurasthenic.

When the foregoing train of symptoms supervenes upon chronic pelvic mischief, they demand prompt and energetic treatment. First of all, by appropriate gynaecological measures, the primary pelvic disorder must be attacked, and if possible removed. Unless this be done, it is futile to expect a cure of the secondary neurasthenic symptoms. These latter are best treated by rest, massage, electrical treatment, diet and change of scene, preferably in a hospital or nursing-home, with skilled nursing, under careful medical supervision. It is unnecessary in this short article to discuss the details of the so-called 'rest-cure.' A few maxims may, however, be recalled. Isolation from all outside influences is generally advisable, the patient receiving neither visitors nor letters during the course of the cure. Tactful nurses and masseuses, together with the encouraging suggestions provided by the physician's daily visit, will serve to prevent ennui or boredom. Although a routine of treatment must be faithfully followed, the patient should be impressed with the fact that this routine is not a mere ready-made affair, but that it has been specially adapted for her individual case by a study of her own particular symptoms.

C. MENTAL DISEASES OF PREGNANCY AND THE PUERPERIUM

Pregnancy and the puerperium are essentially physiological conditions, and therefore cannot of themselves cause insanity. Nevertheless, short of actual insanity, a pregnant woman sometimes undergoes a temporary change in character and disposition, especially during the first few weeks or months of pregnancy. Curious "longings" for abnormal articles of diet, or equally sudden and unreasonable distastes, are so familiar to the lay public as to constitute part of the popular symptomatology of pregnancy.

To produce actual insanity in pregnant or puerperal women some additional factor or factors must exist. Of these the most important is a congenital neuropathic diathesis. Secondly the occurrence of infections, especially during the puerperium, is of great importance; and finally an illegitimate pregnancy, with its attendant shame and distress, is more likely to be associated with insanity than if the patient be married.

Gestational Insanity.—In a small proportion of pregnant women, in the presence of one or more of the foregoing additional factors, a mild variety of mental confusion develops in the early weeks or months of pregnancy, and the patient becomes depressed and even suicidal. In most cases of this sort, the mental symptoms clear up long before the pregnancy is completed.

In other cases mental symptoms arise for the first time during the later months of pregnancy. In such cases the depression and mental confusion are more marked, and, even when the pregnancy is over, may last throughout the puerperium. The prognosis, nevertheless, is almost always favourable.

Puerperal Insanity.—Much more frequent and important is the insanity which occasionally supervenes during the puerperium, generally within the first weeks after parturition. Here it is probable that toxæmia and exhaustion play an important rôle. Toxæmia does not necessarily imply septic infection, although this is sometimes present; it may arise from other toxins, autogenous in origin, associated with the altered metabolism of the puerperium. Puerperal insanity occurs most frequently in elderly primiparae and may occasionally recur with succeeding pregnancies. The symptoms are those of mental confusion with hallucinations and delusions, culminating in active, excited delirium. The onset of mental symptoms is usually preceded by insomnia, constipation, and anorexia. Occasionally the patient develops an unnatural aversion for her child or her husband. Finally, within a few days or even within a few hours, acute mental symptoms are established, with confusion, maniacal excitement, and violence, lasting for two or three weeks. Then the

excitement subsides, the mental confusion clears up, the patient begins to realize her surroundings, and, within three or four months, appetite for food returns, and convalescence is established.

Climacteric Insanity.—The menopause is associated with various bodily symptoms to which we have already referred. As regards its relation to actual insanity, if there be already a predisposition to mental disease, this now has a definite tendency to become exaggerated, contrary to the popular belief that nervous or mental symptoms will “clear up” at the change of life. The symptoms of climacteric insanity are usually those of melancholia, combined with mental confusion, this latter element being probably of toxic origin and associated with obstinate constipation. The course of the disease is a slow one. Rather more than half the cases recover in from three months to a year. Others subside into a terminal dementia.

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